ElixirGroup

Мapa puta dekarbonizacije na primeru fabrika za proizvodnju mineralnih đubriva i fosforne kiseline u Srbiji

Decarbonization Roadmap on the Example of Factories for the Production of Mineral Fertilizers and Phosphoric Acid in Serbia

#ЕУ ЗА ТЕБЕ

ЕУ за Зелену агенду у Србији

UNDP

Urednik/Editor**:** Alija Salkunić
Autori/Authors**:** Alija Salkunić, Ljiljana Stanojević, Slavica Bogdanović, Jelena Mago
Recenzent/Reviewer**:** Riccardo Quaggiato
Izdavač/Publisher**:** Elixir Group DOO, Hajduk Veljkova 1,15000 Šabac, Srbija
Priredila/Prepared by**:** Margareta Musić
Dizajn/Design**:** Isidora Dimitrijević
Godina izdanja/Release year**:** 2023

Fabrike za proizvodnju fosforne kiseline i NPK mineralnih đubriva - Elixir Prahovo
Factories for the Production of Phosphoric Acid and Mineral Fertilizers - Elixir Prahovo

Izrada „Mape puta dekarbonizacije na primeru fabrika za proizvodnju mineralnih đubriva i fosforne kiseline u Srbiji" je podržana u okviru projekta „EU za Zelenu agendu u Srbiji". Ovu inicijativu, uz tehničku i finansijsku podršku Evropske unije (EU) i u partnerstvu sa Ministarstvom zaštite životne sredine, sprovodi Program Ujedinjenih nacija za razvoj (UNDP), u saradnji sa Ambasadom Švedske i Evropskom investicionom bankom (EIB), uz dodatna finansijska sredstva koja su obezbedile vlade Švedske, Švajcarske i Srbije.

Sadržaj ove publikacije, kao i rezultati prikazani u njoj, su odgovornost autora i ne odražavaju nužno stavove EU, EIB-a, UNDP-a, Vlada Švedske, Švajcarske i Srbije.

The creation of the "Decarbonization Roadmap on the Example of Factories for the Production of Mineral Fertilizers and Phosphoric Acid in Serbia" is supported within the "EU for Green Agenda in Serbia " project. The project "EU for Green Agenda in Serbia", with the technical and financial support of the European Union and in partnership with the Ministry of Environmental Protection, is implemented by UNDP in cooperation with the Embassy of Sweden and the European Investment Bank (EIB), with additional financial resources provided by the governments of Sweden, Switzerland and Serbia.

The content of this publication, as well as the results presented in it, are the responsibility of the author and do not necessarily reflect the views of the EU, EIB, UNDP, the Government of Sweden, Switzerland and Serbia.

Sadržaj
Content

Reč autora:

Mapa puta dekarbonizacije na primeru fabrika za proizvodnju mineralnih đubriva i fosforne kiseline u Srbiji predstavlja industrijski vodič, nastao pre svega za potrebe kompanije Elixir Group s težnjom da svoj proizvodni program i poslovne aktivnosti učini što približnije ugljenično neutralnim. Izrada ove publikacije je podržana kao jedno od 16 najboljih rešenja za unapređenje zelene tranzicije u Srbiji kroz projekat „EU za Zelenu agendu u Srbiji".

U pripremama za zelenu tranziciju i dekarbonizaciju fabrika za proizvodnju kompleksnih mineralnih đubriva i fosforne kiseline, najpre je bilo potrebno naći objedinjujuć informator ili uputstvo sa smernicama za implementaciju novih procedura i praksi smanjenja karbonskog otiska ne samo pojedinačnih proizvoda, već cele fabrike. Jedan takav dokument koji bi bio dovoljno jasan i koji bi dao konkretne smernice nismo pronašli i zato smo i krenuli u kreiranje sopstvene Mape puta za koju smo uvereni da će biti od koristi svim kompanijama koje podležu CBAM mehanizmu (Carbon Boarder Adjustment Mechanism), kao i svim ETS postrojenjima koja emituju značajnu količinu gasova sa efektom staklene bašte, posebno kroz praktične savete u okviru izbora korektivnih mera. U skladu sa ovim uverenjem i uverenjem da će dekarbonizaciju svake države privreda pokrenuti u ovoj publikaciji dosta se pažnje posvećuje upoznavanju sa metodologijom za procenu životnog ciklusa proizvoda, koja se bavi pitanjima korišćenja resursa, ekološkim posledicama direktnih i indirektnih emisija, odnosno svim aspektima i uticajima na životnu sredinu jednog proizvoda. Kada se posmatra isključivo uticaj na klimatske promene govorimo o ugljeničnom ili karbonskom otisku, koji predstavlja meru ukupne emisije gasova sa efektom staklene bašte koja se emituje tokom životnog ciklusa određenog proizvoda. Merenje karbonskog otiska pomaže kompanijama i pojedincima da bolje razumeju i smanje uticaj proizvoda na klimatske promene, identifikujući oblasti gde mogu smanjiti emisije tokom čitavog životnog ciklusa proizvoda. Ovo je važno u nastojanju da se smanji ukupna globalna emisija gasova sa efektom staklene bašte i usmeri prema održivijem i manje štetnom načinu proizvodnje i potrošnje.

Alija Salkunić

Author's preface:

Decarbonization Roadmap on the Example of Factories for the Production of Mineral Fertilizers and Phosphoric Acid in Serbia is an industrial guide, created primarily for the needs of the company Elixir Group with the aspiration to make its production program and business activities as close to carbon neutral as possible. The production of this publication was supported as one of the 16 best solutions for the improvement of the green transition in Serbia through the „EU for Green Agenda in Serbia" project.

In preparation for the green transition and decarbonization of factories for the production of complex mineral fertilizers and phosphoric acid, it was first necessary to find a unifying information or instruction book with guidelines for the implementation of new procedures and practices for reducing the carbon footprint of not only individual products, but of the entire factory as well. We did not find one such document that would be clear enough and that would give us concrete guidelines, and that is why we set out to create our own Roadmap, which we are convinced will be useful to all companies subject to the CBAM mechanism (Carbon Boarder Adjustment Mechanism), as well as to all ETS plants that emit a significant amount of greenhouse gases, especially through practical advice in the selection of corrective measures. In accordance with this belief and the belief that the decarbonization of each country's economy will be initiated in this publication, a lot of attention is paid to getting to know the methodology for product life cycle assessment, which deals with issues of resource use, environmental impact of direct and indirect emissions, i.e. all aspects and impacts on the environment by a product. When the impact on climate change is considered exclusively, we are talking about the carbon footprint, which is a measure of the total emission of greenhouse gases emitted during the life cycle of a certain product. Carbon footprint measurement helps companies and individuals better understand and reduce the impact of products on climate change, identifying areas where they can reduce emissions throughout the product's life cycle. This is important in the effort to reduce the total global emission of greenhouse gases and move towards a more sustainable and less harmful way of production and consumption.

Alija Salkunić

Klimatske promene
Climate change

Termin klimatske promene označava dugoročne promene u prosečnim vremenskim uslovima na Zemlji, odnosno promene meteoroloških i klimatoloških parametara – temperature, padavina, vetra i drugih. Njihovi uzroci mogu biti prirodne promene u aktivnosti Sunca ili velikih vulkanskih erupcija, ali je od XIX veka naučno potvrđeno da presudan uticaj na ubrzanje tih promena imaju čovekove aktivnosti.

Glavni uzrok ljudskih uticaja na klimatske promene jeste emisija gasova sa efektom staklene bašte (GHGs, greenhouse gases emisije), poput ugljen-dioksida (CO_2), metana (CH_4) i azot-suboksida (N_2O), koji uglavnom nastaju kao posledica rada sektora za dobijanje energije (dominantno kada se koriste fosilna goriva), industrije, transporta, građevinarstva, intezivne poljoprivrede. Ovi gasovi zadržavaju toplotu sunčeve svetlosti u atmosferi, čime se povećava temperatura na Zemlji - fenomen poznat kao globalno zagrevanje.

Posledice klimatskih promena su danas sve vidljivije i dokazuje se da, osim što su opasne po životnu sredinu, one ugrožavaju zdravlje i život živih bića.

Prema Nacionalnoj vazduhoplovnoj i svemirskoj organizaciji (NASA), svetska temperatura je u 2022. godini bila za 1,1 °C viša od referentne (kao etalon uzima se temperatura u preindustrijskom periodu).

Svetska meteorološka organizacija (SMO) u maju 2023. godine izvestila je da će globalne temperature verovatno porasti na rekordne nivoe, u narednih pet godina. Smatra se da je ovo podstaknuto gasovima sa efektom staklene bašte koji zadržavaju toplotu i prirodnim događajem El Ninjo, koji nastaje kada površinska voda u ekvatorijalnom Pacifiku postane toplija od proseka. Postoji 66 % verovatnoće da će godišnja prosečna globalna temperatura blizu površine, između 2023. i 2027. godine, biti za više od 1,5°C iznad predindustrijskih nivoa tokom najmanje jedne godine. Takođe, postoji i 98 % verovatnoće da će bar jedna od narednih pet godina, i petogodišnji period u celini, biti najtopliji do sada.

The term climate change means long-term changes in the average weather conditions on Earth, i.e. changes in meteorological and climatological parameters - temperature, precipitation, wind and others. Its causes can be natural changes in the activity of the Sun or large volcanic eruptions, but it has been scientifically confirmed since the 19th century that human activities have a decisive influence on the acceleration of these changes.

The main cause of human impacts on climate change is the emission of greenhouse gases (GHGs), such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), which are mainly produced as a result of the sector's work for obtaining energy (dominantly when fossil fuels are used), industry, transport, construction, intensive agriculture. These gases trap the heat of sunlight in the atmosphere, increasing the Earth's temperature - a phenomenon known as global warming.

The consequences of climate change are increasingly visible today and it is proven that, in addition to being dangerous for the environment, they threaten the health and life of living beings.

According to the National Aeronautics and Space Administration (NASA), the world temperature in 2022 was 1.1 °C higher than the reference (the temperature in the pre-industrial period is taken as a benchmark).

The World Meteorological Organization (WMO) reported in May 2023 that global temperatures are likely to rise to record levels within the next five years. This is thought to be driven by heat-trapping greenhouse gases and the natural El Niño effect, which occurs when surface water in the equatorial Pacific becomes warmer than average. There is a 66% probability that the annual average global near-surface temperature between 2023 and 2027 will be more than 1.5°C above pre-industrial levels for at least one year. There is also a 98% probability that at least one of the next five years, and the five-year period as a whole, will be the warmest on record.

Direktne posledice klimatskih promena na ekonomiju i društvo
Direct consequences of climate change on the economy and society

Klimatske promene, uključujući povećanje učestalosti i intenziteta ekstrema, nepovoljno utiču na bezbednost hrane i kopnene ekosisteme a takođe doprinose i dezertifikaciji i degradaciji kopnenih površina u mnogim regionima. One predstavljaju i jaku globalnu pretnju ekonomijama i društvu. Naime, Međunarodna organizacija rada predviđa da će u svakoj godini do 2030. ukupno radno vreme čovečanstva opadati za 2,2 % – što je ekvivalent produktivnosti od 80 miliona poslova sa punim radnim vremenom – jer će visoke temperature onemogućiti rad ili primoravati na usporenje tempa rada. Istovremeno, čak 1,2 milijarde radnih mesta (40 %) širom sveta zavisi od zdrave i stabilne životne sredine.

Climate change, including an increase in the frequency and intensity of extremes, adversely affects food security and terrestrial ecosystems, and also contributes to desertification and land degradation in many regions. It also represents a strong global threat to economies and society. Namely, the International Labor Organization predicts that in each year until 2030, the total working time of humanity will decrease by 2.2% - which is equivalent to the productivity of 80 million full-time jobs - because high temperatures will make work impossible or force the pace of work to slow down. At the same time, as many as 1.2 billion jobs (40%) around the world depend on a healthy and stable environment.

Troškovi sanacije šteta nastalih od posledica klimatskih promena skoro uvek su izuzetno visoki (primera radi, najduža superćelijska oluja, koja je pogodila Nemačku i Češku, trajala je sedam sati i napravila je štetu od gotovo četiri milijarde evra; za superćelijske oluje se smatra da su direktne posledice klimatskih promena).

Srbija se poslednju deceniju takođe suočava sa posledicama klimatskih promena. Ogromna količina padavina je maja 2014. godine dovela do velikih poplava, pri čemu je pored ogromne materijalne štete bilo i ljudskih žrtava (stradalo je više od 30 osoba). U julu i avgustu ove godine, superćeliske oluje su prvi put u svojoj istoriji zahvatile teritoriju Republike Srbije i okolne zemlje Balkanskog poluostrva, a one nastaju kada postoji ekstremna termička nestabilnost atmosfere. Ta superćelijska oluja je odnela pet života i načinila veliku materijalnu štetu na našim prostorima.

The costs of repairing damages caused by the consequences of climate change are almost always extremely high (for example, the longest supercell storm, which hit Germany and the Czech Republic, lasted seven hours and caused damage of almost four billion euros; supercell storms are considered to be directly consequences of climate change).

In the last decade, Serbia has also been facing the consequences of climate change. In May 2014, the huge amount of rainfall led to major floods, where in addition to huge material damage, there were also human casualties (more than 30 people died). In July and August of this year, for the first time in its history, supercell storms affected the territory of the Republic of Serbia and the surrounding countries of the Balkan Peninsula, and they occur when there is extreme thermal instability of the atmosphere. That supercell storm took five lives and caused great material damage in our area.

Ako se klima menja, zašto se ne bismo promenili i mi?

If the climate is changing, why shouldn't we?

Odgovor Evropske unije (EU) na borbu protiv klimatskih promena i obaveze koje proizilaze iz Pariskog sporazuma usvojenog 2015. godine na samitu Ujedinjenih Nacija (UN) jeste Evropski zeleni dogovor (the EU Green Deal) donet 2019. godine.

Evropski zeleni dogovor (EZD) je strategija rasta za postizanje klimatske neutralnosti u zemljama EU do 2050. godine, koja istovremeno podrazumeva razdvajanje ekonomskog rasta od potrošnje resursa. Ciljevi EZD treba da se implementiraju tako da privreda EU dugoročno ostane konkurentna i da nijedna osoba ili region ne budu zapostavljeni.

Glavni cilj Evropskog zelenog dogovora jeste smanjenje emisija gasova sa efektom staklene bašte u sferi energetike, transporta, industrije i poljoprivrede, te povećanje apsorpcije gasova iz atmosfere od strane šuma i zemljišta (npr. širenjem mreže zaštićenih područja, obnovom ekosistema i šumskih prirodnih resursa).

Uz ovako postavljene ciljeve, EU iskoračuje ka krajnjoj klimatskoj neutralnosti kojom obavezuje sve države članice. Tako su na osnovu uredbe, Evropskog propisa o klimi, države Unije u obavezi da deluju u zajedničkom ekološkom cilju, a propis precizira i da to moraju činiti na pravičan i solidaran način.

Kada pogledamo unazad, težnja ka klimatskoj neutralnosti određuje pravac delovanja u evropskoj politici dugi niz godina. Zahvaljujući tome, politika postaje predvidiva, što je od ključnog značaja za investitore i preduzetnike.

Do 2030. godine, Evropska unija treba da postigne najmanje 55 % smanjenja emisija gasova sa efektom staklene bašte u poređenju sa nivoima iz 1990. godine. Ovaj međucilj uključen je i u Zakonu o klimi. Zakon takođe određuje na koji će način biti postavljen cilj za 2040. godinu.

The response of the European Union (EU) to the fight against climate change and the obligations arising from the Paris Agreement adopted in 2015 at the United Nations (UN) summit is the European Green Deal adopted in 2019.

The European Green Deal (EGD) is a growth strategy for achieving climate neutrality in the EU countries by 2050, which at the same time implies the separation of economic growth from resource consumption. The EGD objectives should be implemented so that the EU economy remains competitive in the long term and that no person or region is left behind.

The main goal of the European Green Deal is to reduce emissions of greenhouse gases in the sphere of energy, transport, industry and agriculture, and to increase the absorption of gases from the atmosphere by forests and land (e.g. by expanding the network of protected areas, restoring ecosystems and forest natural resources).

With the goals set in this way, the EU is stepping towards ultimate climate neutrality, which obligates all member states. Thus, based on the regulation, the European regulation on climate, the states of the Union are obliged to act towards a common environmental goal, and the regulation specifies that they must do so in a fair and solidary manner.

In retrospect, the pursuit of climate neutrality has determined the course of action in European politics for many years. Thanks to this, the policy becomes predictable, which is of key importance for investors and entrepreneurs.

By 2030, the European Union needs to achieve at least a 55% reduction in greenhouse gas emissions compared to 1990 levels. This intermediate goal is also included in the Law on Climate. The law also determines how the goal for 2040 will be set.

Uredba predviđa i:
- usklađivanje s klimatskim ciljevima svih politika EU, kao i
- razvoj smernica u saradnji sa pojedinačnim industrijama, odnosno način za postizanje klimatske neutralnosti u pojedinačnim privrednim sektorima.

Evropski zeleni dogovor se sprovodi kroz paket izmena strategija i propisa EU i novih inicijativa, poznatih kao „Spremni za 55" (Fit for 55), ali i kroz sistem finansiranja usvojen u okviru Evropskog investicionog plana Zelenog dogovora (EGDIP) koji predviđa sredstva za investicije za EZD u iznosu od milijardu evra.

Potpisivanjem Sofijske deklaracije o Zelenoj agendi za Zapadni Balkan u novembru 2020. godine, države regiona su se obavezale da će sprovoditi Zelenu agendu kao „mapu puta" za seriju konkretnih poteza i mera koje će rezultirati u nisko-ugljeničnom razvoju i ekonomskom rastu koji je usklađen sa principima održivog razvoja.

Ključne oblasti Zelene Agende za Zapadni Balkan su:
- Dekarbonizacija
- Cirkularna ekonomija
- Smanjenje zagađenja
- Održiva poljoprivreda
- Zaštita biološke raznovrsnosti

Zelena agenda za zapadni Balkan, čija je potpisnica i Republika Srbija, je utemeljena na Evropskom zelenom dogovoru i predstavlja strategiju regionalnog razvoja koja ima za cilj da odgovori na izazove klimatskih promena i zelene tranzicije i da pomogne zemljama Zapadnog Balkana da usklade propise o životnoj sredini sa evropskim standardima i normama.

The regulation also provides for:
- alignment with the climate goals of all EU policies, as well as
- development of guidelines in cooperation with individual industries, that is, a way to achieve climate neutrality in individual economic sectors.

The European Green Deal is implemented through a package of changes to EU strategies and regulations and new initiatives, known as „Fit for 55", but also through the financing system adopted as part of the European Green Deal Investment Plan (EGDIP), which provides funds for investments for EGD in the amount of one billion euros.

By signing the Sofia Declaration on the Green Agenda for the Western Balkans in November 2020, the countries of the region committed to implement the Green Agenda as a „roadmap" for a series of concrete moves and measures that will result in low-carbon development and economic growth that is harmonized with the principles of sustainable development.

The key areas of the Green Agenda for the Western Balkans are:
- Decarbonization
- Circular economy
- Reduction of pollution
- Sustainable agriculture
- Protection of biological diversity

The Green Agenda for the Western Balkans, to which the Republic of Serbia is a signatory, is based on the European Green Deal and represents a regional development strategy that aims to respond to the challenges of climate change and the green transition and to help the countries of the Western Balkans harmonize environmental regulations with European standards and norms.

Zelena tranzicija i dekarbonizacija kao odgovor na klimatske promene

Green transition and decarbonization as a response to climate change

U cilju postizanja klimatske neutralnosti zahteva se radikalno smanjenje emisija gasova sa efektom staklene bašte, pre svega ugljen-dioksida, a samim tim i dekarbonizacija privrede. Najvažniji izvor emisije CO_2 koju je prouzrokovao čovek jeste sagorevanje fosilnih goriva. U 2019. godini je zavisnost privrede EU od uvoza kamenog uglja iznosila 70 %, od prirodnog gasa 90 % i nafte 97 %, a vrednost uvoza ovih energenata dostigla je 363 milijarde evra, što odgovara 2,6 % evropskog BDP-a, odnosno trošku u visini više od 9 miliona radnih mesta u Evropi.

Zbog poremećaja na svetskom energetskom tržištu izazvanih invazijom Rusije na Ukrajinu, Evropska komisija je u maju 2022. godine usvojila plan REPowerEU. On podrazumeva ubrzanje energetske tranzicije i oslobađanje zavisnosti od ruskih fosilnih goriva. Ovaj cilj treba postići uštedom energije, diversifikacijom snabdevanja energijom i bržim uvođenjem obnovljivih izvora energije u cilju zamene fosilnih goriva u domaćinstvima, industriji i energetici. To znači ubrzanje aktivnosti koje se sprovode u okviru EZD.

Ciljeve EZD treba postići, između ostalog, kroz zelenu tranziciju u industriji koja podrazumeva:
- povećanje energetske efikasnosti procesa i proizvoda;
- korišćenje energije iz niskougljeničnih izvora;
- prelazak sa linearnog modela upravljanja (uzmi, proizvedi, upotrebi, baci) na model cirkularne ekonomije (efikasna upotreba i kontinuirana obnova resursa);
- prelazak na tehnologije proizvodnje neutralne po klimu, naročito u energetski intenzivnim sektorima;
- prilagođavanje poslovanja razvoju ekološki i klimatski prihvatljive i pametne mobilnosti, što se odnosi na transportnu i automobilsku industriju.

In order to achieve climate neutrality, a radical reduction of greenhouse gas emissions, primarily carbon dioxide, is required, and thus the decarbonization of the economy. The most important source of human-caused CO_2 emissions is the burning of fossil fuels. In 2019, the dependence of the EU economy on the import of hard coal amounted to 70%, on natural gas 90% and on oil 97%, and the value of the import of these energy sources reached 363 billion euros, which corresponds to 2.6% of the European GDP, i.e. the cost in the amount of more than 9 million jobs in Europe.

Due to disruptions in the world energy market caused by Russia's invasion of Ukraine, the European Commission adopted the REPowerEU plan in May 2022. It implies the acceleration of the energy transition and the release of dependence on Russian fossil fuels. This goal should be achieved by saving energy, diversifying energy supply and faster introduction of renewable energy sources in order to replace fossil fuels in households, industry and energy. This means the acceleration of the activities carried out within the EGD.

The goals of EGD should be achieved, among other things, through a green transition in the industry, which includes:
- increasing the energy efficiency of processes and products;
- use of energy from low-carbon sources;
- transition from a linear management model (take, produce, use, throw) to a circular economy model (efficient use and continuous renewal of resources);
- transition to climate-neutral production technologies, especially in energy-intensive sectors;
- adapting business to the development of environmentally and climate-friendly and smart mobility, which refers to the transport and automotive industry.

Evropska industrijska politika podrazumeva dvosmernu industrijsku tranziciju (twin transition), odnosno povezivanje zelene tranzicije sa digitalnom tranzicijom. Zahvaljujući tome, biće lakše ostvariti ciljeve EZD i istovremeno izgraditi konkurentnost evropske industrije u eri industrijske revolucije 4.0 koja se pre svega tiče digitalizacije. Očekuje se da će digitalna tranzicija pomoći da se ostvari dekarbonizacija (smanjenje ili uklanjanje emisija ugljen-dioksida u atmosferu) i prelazak na cirkularnu ekonomiju, potpomoći produktivnost i omogućiti zaposlenima da steknu nove veštine.

Jedna od preventivnih mera za dekarbonizaciju jeste i Mehanizam regulisanja prekograničnih emisija ugljenika (Carbon Border Adjustment Mechanism - CBAM) koji nalaže oporezivanje ugrađenih emisija sa efektom staklene bašte u proizvode koji se uvoze na tržište EU. Ovaj Mehanizam komplementaran je Sistemu trgovine emisijama Evropske unije (EU Emission Trading System – EU ETS), kojim se vrše naplate emisija GHG. Uvođenje CBAM imaće značajan uticaj na socio-ekonomsku sliku država koje nisu članice EU, u zavisnosti od ukupnog izvoza proizvoda obuhvaćenim CBAM na njeno tržište i od stepena dekarbonizacije.

Potpisivanjem Sofijske deklaracije o Zelenoj agendi za Zapadni Balkan, Republika Srbija se obavezala da smanji GHG emisije do 2030. godine za 33,3% u odnosu na 1990. godinu, odnosno za 13,2% u odnosu na 2010. godinu. Da bi to ostvarila, neophodno je sprovesti brojne aktivnosti, a najpre napuštanje fosilnih goriva u korist obnovljivih izvora energije, kao i prelazak na cirkularni model ekonomije i smanjenje otpada. U skladu sa tim Ministarstvo zaštite životne sredine donelo je Zakon o klimatskim promenama („Sl. glasnik RS", br. 26/2021) sa pratećim podzakonskim aktima, Nacionalno utvrđeni doprinos (NDC) smanjenju emisija gasova sa efektom staklene bašte Republike Srbije za period 2021 – 2030. godine, kao i Strategiju niskougljeničnog razvoja Republike Srbije za period od 2023. do 2030. godine sa projekcijama do 2050. godine („Sl. glasnik RS", br. 46/2023).

Da bi industrija mogla da uđe u proces zelene tranzicije i dekarbonizacije, najpre je potrebno da uoči koji su to delovi proizvodnog procesa najkritičniji, a potom da preduzme preventivne akcije.

The European industrial policy implies a two-way industrial transition (twin transition), that is, connecting the green transition with the digital transition. Thanks to this, it will be easier to achieve the objectives of the EGD and at the same time build the competitiveness of the European industry in the era of industrial revolution 4.0, which primarily concerns digitization. It is expected that the digital transition will help achieve decarbonization (reduction or elimination of carbon dioxide emissions into the atmosphere) and transition to a circular economy, support productivity and enable employees to acquire new skills.

One of the preventive measures for decarbonization is the Carbon Border Adjustment Mechanism - CBAM, which mandates the taxation of built-in emissions with the greenhouse effect in products that are imported to the EU market. This Mechanism is complementary to the EU Emission Trading System - EU ETS, by which GHG emissions are charged. The introduction of CBAM will have a significant impact on the socio-economic picture of non-EU countries, depending on the total export of products covered by CBAM to its market and on the degree of decarbonization.

By signing the Sofia Declaration on the Green Agenda for the Western Balkans, the Republic of Serbia undertook to reduce GHG emissions by 2030 by 33.3% compared to 1990, or by 13.2% compared to 2010. In order to achieve this, it is necessary to carry out numerous activities, first of all abandoning fossil fuels in favor of renewable energy sources, as well as switching to a circular economy model and reducing waste. In accordance with that, the Ministry of Environmental Protection adopted the Law on Climate Change („Official Gazette of RS", No. 26/2021) with accompanying by-laws, the Nationally Determined Contribution (NDC) to the reduction of greenhouse gas emissions of the Republic of Serbia for the period 2021 – 2030, as well as the Low-Carbon Development Strategy of the Republic of Serbia for the period from 2023 to 2030 with projections up to 2050 („Official Gazette of the RS", No. 46/2023).

In order for the industry to enter the process of green transition and decarbonization, it is first necessary to identify which parts of the production process are the most critical, and then to take preventive actions.

Zdrava životna sredina je preduslov dobrog života i opstanka živih bića

A healthy environment is a prerequisite for a good life and the survival of living beings

Razlozi za mitigaciju i adaptaciju na klimatske promene su više nego jasni; jul 2023. godine je bio obeležen nezapamćenim toplotnim talasom, katastrofalnim poplavama izazvanim superćelijskim olujama, požarima sa ljudskim žrtvama. Što su klimatske promene brže i što se napori za njihovo prilagođavanje budu odlagali, to će biti teže i skuplje reagovanje na njih.

Adaptacija se odnosi na prilagođavanja u ekološkim, društvenim ili ekonomskim sistemima kao odgovor na stvarne ili očekivane klimatske stimuluse i njihove efekte. Ove promene se odnose na promene dosadašnjih rešenja koje zemlje i zajednice treba da razviju i sprovedu u vidu akcija kako bi odgovorile na sadašnje i buduće uticaje klimatskih promena, odnosno ublažile njihov razvoj.

Mnoge kompanije su zainteresovane da smanje ugljenični otisak proizvoda, kako bi postale ekološki prihvatljivije i time ublažile svoj uticaj na životnu sredinu. Prvi korak u tome je svakako „skeniranje" postojećeg stanja što se može postići izradom studije Procena životnog ciklusa (LCA - Life Cycle Assessment) proizvoda. Ona jeste sveobuhvatan metod baziran na standardima ISO 14040 (ISO 14040:2006 Environmental management Life cycle assessment - principles and framework) i ISO 14044 (ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines), koji služi za procenu i kvantifikaciju uticaja na životnu sredinu tokom celog životnog veka proizvoda - od nabavke i ekstrakcije sirovina, proizvodnje, upotrebe proizvoda, do konačnog odlaganja proizvoda (ili ponovne upotrebe). Zbog svega navedenog, LCA se može smatrati ključnim alatom za identifikaciju uticaja i definisanje ciljeva dekarbonizacije. Kada LCA studija kao kategoriju uticaja prati samo globalno zagrevanje, tada takvu vrstu studije nazivamo studijom ugljeničnog otiska proizvoda (CFP studija; CFP - Carbon Footprint).

The reasons for mitigation and adaptation to climate change are more than clear; July 2023 was marked by an unprecedented heat wave, catastrophic floods caused by supercell storms, fires with human casualties. The faster climate changes and the longer adaptation efforts are delayed, the more difficult and expensive it will be to respond to them.

Adaptation refers to adjustments in ecological, social or economic systems in response to actual or anticipated climate stimuli and their effects. These changes refer to changes in the current solutions that countries and communities should develop and implement in the form of actions in order to respond to the current and future impacts of climate change, that is, to mitigate their development.

Many companies are interested in reducing the carbon footprint of their products, in order to become more environmentally friendly and thereby mitigate their impact on the environment. The first step in this is certainly the „scanning" of the existing state, which can be achieved by creating a Life Cycle Assessment (LCA) study of the product. It is a comprehensive method based on the standards ISO 14040 (ISO 14040:2006 Environmental management Life cycle assessment - principles and framework) and ISO 14044 (ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines), which serves for assessment and quantification of the impact on the environment during the entire life cycle of the product - from the procurement and extraction of raw materials, production, use of the product, to the final disposal of the product (or reuse). Because of all the above, LCA can be considered a key tool for identifying impacts and defining decarbonization goals. When the LCA study only monitors global warming as an impact category, then we call this type of study a product carbon footprint study (CFP study; CFP - Carbon Footprint).

Procena životnog ciklusa proizvoda i izračunavanje ugljeničnog otiska

Product life cycle assessment and carbon footprint calculation

Životni ciklus proizvoda odnosi se na sve međusobno povezane faze koje proizvod prolazi od stvaranja do konačnog odlaganja, odnosno od eksploatacije prirodnih resursa potrebnih za njegovu proizvodnju, do krajnjeg oslobađanja toksičnih i zagađujućih materija u životnu sredinu kada se na kraju odlože. Životni ciklus proizvoda obično uključuje sledećih pet koraka: ekstrakcija sirovina, proizvodnja i obrada, prodaja, transport proizvoda, njegova upotreba i odlaganje otpada. U ekološki sve osvešćenijem svetu, već u pristupu dizajniranja novih proizvoda, uzima se u obzir njihov potencijalni uticaj na životnu sredinu, te planiranje novog proizvoda prati i ocenjivanje njegovog životnog ciklusa. Na taj način se, na samom početku, identifikuju i kvantifikuju njegovi uticaji koji su povezani sa proizvodnjom, eksploatacijom ili krajnjim uklanjanjem.

The life cycle of a product refers to all the interconnected stages that the product goes through from creation to final disposal, i.e. from the exploitation of natural resources needed for its production, to the final release of toxic and polluting substances into the environment when they are finally disposed of. The life cycle of a product usually includes the following five steps: extraction of raw materials, production and processing, sale, transportation of the product, its use and waste disposal. In an increasingly environmentally conscious world, already in the approach to designing new products, their potential impact on the environment is taken into account, and the planning of a new product is accompanied by an assessment of its life cycle. In this way, at the very beginning, its impacts related to production, exploitation or final removal are identified and quantified.

Dakle, LCA pomaže donosiocima odluka da:

- identifikuju i nenamerne uticaje aktivnosti (npr. nenamena emisija gasova staklene bašte koja može ugroziti prednosti nove tehnologije),
- obezbedi razmatranje svih medija životne sredine kroz ceo životni ciklus (npr. podjednako razmatranje emisija u vazduh, vodu i zemlju tokom izgradnje, rada i stavljanja van pogona postrojenja),
- spreče „prenošenje" problema zagađivanje iz jedne faze u drugu, između geografskih prostora i između medijuma životne sredine (npr. LCA obezbeđuje da se mere zaštite vazduha koje su primenjene na jednom mestu ne „pretvore" u zagađenje voda na drugom),
- identifikuju mogućnosti za poboljšanje ekonomskih i performansi zaštite životne sredine različitih tehnologija, projekata, proizvoda i usluga (npr. kroz identifikaciju kritičnih tačaka tzv. „hotspots" koje je potrebno rešiti),
- komuniciraju efikasnije sa različitim učesnicima koji su zainteresovani za informacije o eventualnim posledicama projekata i tehnoloških opcija (npr. proces izrade LCA zahteva učešće različitih zainteresovanih strana čime se uspostavlja komunikacija i obezbeđuje informisanost o punom uticaju i/ili koristima koje određene promene ili novi proizvodni procesi i proizvodi donose).

Međunarodna organizacija za standardizaciju (ISO) standardizovala je LCA putem serije ISO 14040 nudeći univerzalno prihvaćen metod za merenje kako životni ciklus proizvoda ili usluga utiče na skup ekoloških indikatora. Indikatori se mogu kategorisati kao:

- *šteta po zdravlje ljudi* – pokriva aspekte kao što su formiranje čestica, klimatske promene, toksičnost za ljude i formiranje fotohemijskih oksidanata.
- *oštećenje kvaliteta ekosistema* – uključuje faktore kao što su klimatske promene, zakišeljavanje kopna, ekotoksičnost kopna i mora, eutrofikacija slatkih voda i mora, oštećenje ozona, zauzimanje poljoprivrednog i urbanog zemljišta, prirodna transformacija zemljišta i jonizujuće zračenje.
- *oštećenje resursa* – se odnosi na iscrpljivanje vode, minerala i fosilnih goriva.

Thus, LCA helps decision makers to:

- identify the unintended impacts of activities (e.g. unintended greenhouse gas emissions that may threaten the benefits of new technology),
- ensure consideration of all environmental media throughout the entire life cycle (e.g. equal consideration of emissions to air, water and soil during construction, operation and decommissioning of the plant),
- prevent the „transmission" of pollution problems from one stage to another, between geographical areas and between environmental media (eg LCA ensures that air protection measures applied in one place do not „turn" into water pollution in another),
- identify opportunities for improving the economic and environmental protection performance of various technologies, projects, products and services (e.g. through the identification of critical points, so-called „hotspots" that need to be resolved),
- communicate more effectively with different participants who are interested in information about the possible consequences of projects and technological options (e.g. the LCA process requires the participation of different stakeholders, which establishes communication and ensures information about the full impact and/or benefits that certain changes or new production processes and products bring).

The International Organization for Standardization (ISO) has standardized LCA through the ISO 14040 series offering a universally accepted method for measuring how the life cycle of a product or service affects a set of environmental indicators. Indicators can be categorized as:

- *damage to human health* – covers aspects such as particulate matter formation, climate change, human toxicity and the formation of photochemical oxidants.
- *ecosystem quality damage* - includes factors such as climate change, land acidification, land and sea ecotoxicity, freshwater and sea eutrophication, ozone depletion, agricultural and urban land occupation, natural land transformation and ionizing radiation.
- *resource damage* – refers to the depletion of water, minerals and fossil fuels.

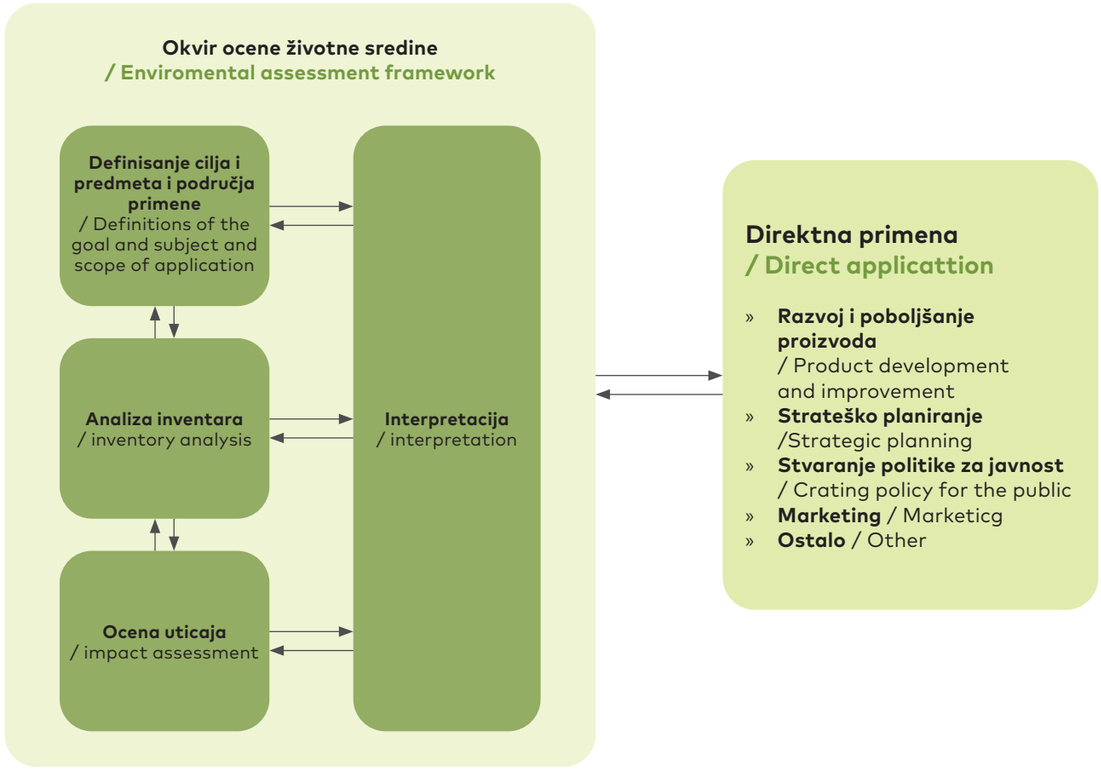
ISO 14040 opisuju četiri faze LCA. Svaka faza ocenjivanja životnog ciklusa je međusobno povezana, tako da pruža okvir koji može da se prilagodi i poboljša tokom celog procesa:

I. Faza definicije cilja i obima
II. Faza analize inventara
III. Faza ocenjivanja uticaja
IV. Faza interpretacije

Ovaj proces je iterativan i često rezultat jednog koraka dovodi do toga da moramo da napravimo korak unazad, kako bi prikupili što više informacija.

ISO 14040 describes four phases of LCA. Each phase of life cycle assessment is interconnected, so it provides a framework that can be adapted and improved throughout the process:
I. Goal and scope definition phase
II. Inventory analysis phase
III. Impact assessment phase
IV. Interpretation phase

This process is iterative and often the result of one step means that we have to take a step back in order to gather as much information as possible.



Izvor: SRPS ISO 14040:2008
Source: SRPS ISO 14040:2008

I Faza definisanja cilja i obima

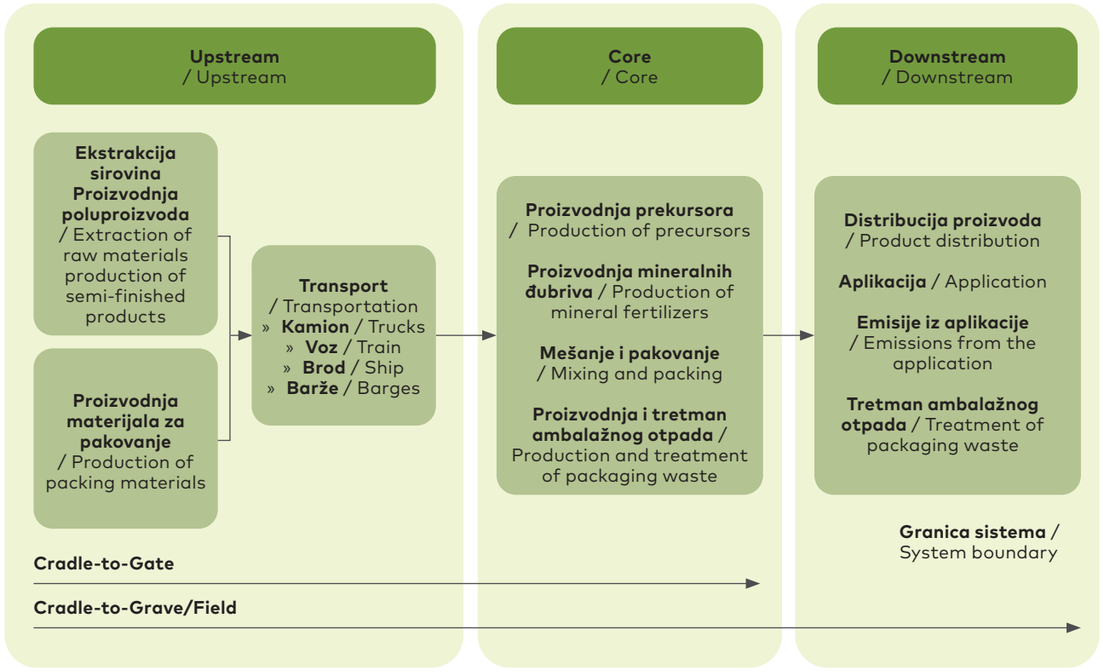
U fazi definisanja cilja i obima, veoma je bitno utvrditi razloge odnosno ciljeve za sprovođenje procene. U okviru ovog koraka, definiše se i deklarisana/funkcionalna jedinica i određuju se granice sistema/obim studije. Deklarisana/funkcionalna jedinica predstavlja jedinicu mere u kojoj se izračunavaju uticaji na životnu sredinu i u kojoj se mogu uporediti sa sličnim proizvodima. U najvećem broju slučajeva definiše se na osnovu pravila kategorije proizvoda (PCR - Product Category Rules). Primer: 1 t mineralnog đubriva.

Obim studije koji se najčešće radi je na nivou Cradle-to-Gate (uključije faze od ekstrakcije sirovina do momenta kada proizvod napušta fabriku) i Cradle-to-Grave (uključuje sve faze životnog ciklusa, od ekstrakcije sirovina, preko proizvodnje, do krajnjeg odlaganja proizvoda).

I Goal and scope definition phase

In the phase of defining the goal and scope, it is very important to determine the reasons or goals for conducting the assessment. Within this step, the declared/functional unit is also defined and the boundaries of the system/scope of the study are determined. The declared/functional unit represents the unit of measure in which environmental impacts are calculated and in which they can be compared with similar products. In most cases, it is defined on the basis of product category rules (PCR - Product Category Rules). Example: 1 t of mineral fertilizer.

The scope of the study that is most often done is at the level of Cradle-to-Gate (including the stages from the extraction of raw materials to the moment when the product leaves the factory) and Cradle-to-Grave (includes all stages of the life cycle, from the extraction of raw materials, through production, to final disposal product).



II Faza analize inventara

Analiza inventara podrazumeva prikupljanje podataka i proceduru proračuna u cilju kvantifikovanja relevantnih ulaza i izlaza sistema proizvoda. Relevantni ulazi su ulazi sirovina i energija, a izlazi su proizvod, koproizvod, otpad i emisije zagađujućih materija u zemljište, vodu ili vazduh. Analiza inventara pomaže da se što bolje razume kako se doprinosi životnoj sredini.

II Inventory analysis phase

Inventory analysis implies the collection of data and the calculation procedure in order to quantify the relevant inputs and outputs of the product system. Relevant inputs are inputs of raw materials and energy, and outputs are products, co-products, waste and emissions of pollutants into the soil, water or air. Inventory analysis helps to better understand how you contribute to the environment.

Faza analize inventara životnog ciklusa se sastoji iz sledećih koraka:

- priprema za prikupljanje podataka,
- prikupljanje podataka,
- postupak obračuna,
- raspodela-alokacija.

Moguće je sprovoditi i kvalitativno i kvantitativno istraživanje kako bi se prikupile potrebne informacije. Nakon sređivanja ulaznih i izlaznih podataka, veoma je bitno da se pažljivo isti analiziraju i procene kako bi se precizno odredili potencijalni rizici i prilike.

Sprovođenje Studije se vrši kroz transparentan pristup, kako u pribavljanju podataka tako i u prezentaciji podataka, jer se na taj način osigurava korisnicima bolje razumevanje primenjenog pristupa i adekvatnu interpretaciju rezultata.

LCA studija može da izazove zainteresovanost i kod lica koje su izvan procesa izrade studije, npr. kod potrošača, nevladinih organizacija, lokalne uprave i industrije. Mišljenja zainteresovanih strana se moraju uzeti u obzir kao i kritičko preispitivanje. Kritičko preispitivanje obezbeđuje da metode koje su korišćene za LCI fazu (inventar životnog ciklusa, eng. Life Cycle Inventory) budu naučno i tehnički ispravne a podaci da budu odgovarajući i jasni u odnosu na cilj Studije.

Poželjno je prikupiti specifične podatke od dobavljača, naročito kada je reč o podacima iz Upstream procesa, međutim, često je takva vrsta podataka nedostupna, tako da se na osnovu dostavljenih informacija biraju reprezentativni podaci iz LCA baze podataka. Ecoinvent baza inventara životnog ciklusa je često birana baza, jer ona pokriva širok spektar sektora na globalnom i regionalnom nivou. Sadrži više od 18000 aktivnosti i „skupove podataka". Ovi skupovi podataka sadrže informacije o industrijskom procesu koji modeliraju, omogućavajući merenje uticaja na životnu sredinu.

Podaci iz Downstream procesa nisu često dostupni i u velikom broju slučajeva se primenjuju generički podaci, na osnovu scenarija iz PCR.

Što je više primarnih podataka koje ulaze u model, to su rezultati studije tačniji i precizniji.

The life cycle inventory analysis phase consists of the following steps:

- preparation for data collection,
- data collection,
- calculation procedure,
- distribution-allocation.

It is possible to conduct both qualitative and quantitative research in order to gather the necessary information. After arranging the input and output data, it is very important to carefully analyze and evaluate them in order to accurately determine potential risks and opportunities.

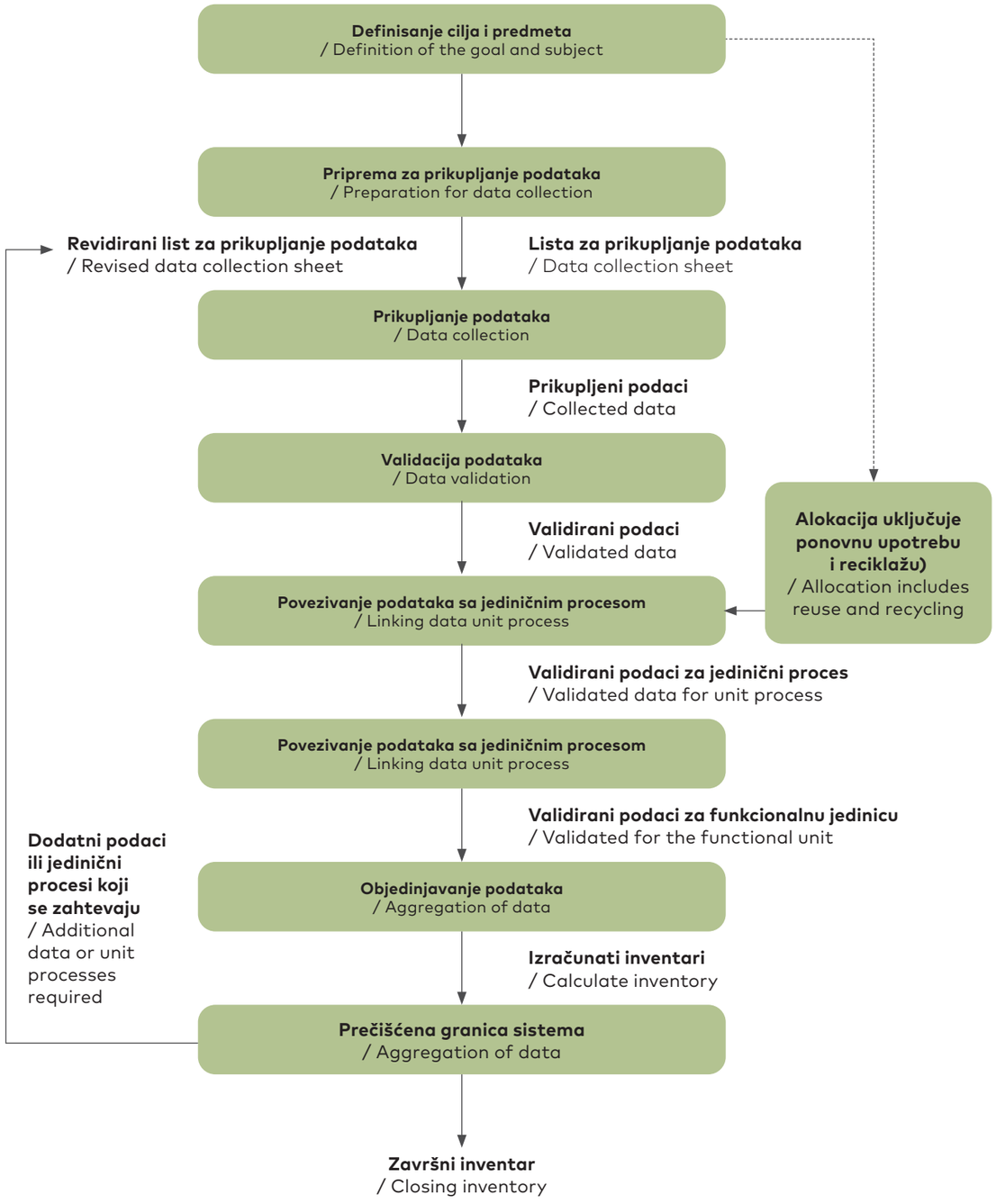
The implementation of the Study is carried out through a transparent approach, both in the acquisition of data and in the presentation of data, because in this way users are ensured a better understanding of the applied approach and an adequate interpretation of the results.

An LCA study can also arouse interest among persons who are outside the study preparation process, e.g. among consumers, non-governmental organizations, local administration and industry. Stakeholder opinions must be taken into account as well as critical review. Critical review ensures that the methods used for the LCI phase (Life Cycle Inventory) are scientifically and technically correct and that the data are appropriate and clear in relation to the goal of the Study.

It is desirable to collect specific data from suppliers, especially when it comes to data from the Upstream process, however, this type of data is often unavailable, so representative data from the LCA database is selected based on the provided information. The Ecoinvent life cycle inventory database is a frequently chosen database, as it covers a wide range of sectors at the global and regional level. It contains more than 18000 activities and „datasets". These datasets contain information about the industrial process they model, allowing environmental impact to be measured.

Data from the Downstream process are not often available and in a large number of cases generic data is applied, based on scenarios from the PCR.

The more primary data that goes into the model, the more accurate and precise the results of the study shall be.



Izvor: SRPS ISO 14044:2009
Source: SRPS ISO 14044:2009

III Faza procene uticaja

Faza procene uticaja ili Ocenjivanje uticaja životnog ciklusa LCIA (eng. life cycle impact assessment) se vrši kroz uspostavljanje relacija - povezanosti ulaza i izlaza sa uticajima na životnu sredinu. Dakle, ova faza obezbeđuje informacije za fazu interperatacije i pruža sveobuhvatni pregled problematike uticaja proizvoda ili usluga na životnu sredinu i resurse.

U ovoj fazi se rezultati LCI faze razvrstavaju u specifično selektovane kategorije uticaja. Kategorije uticaja se koriste za određene rezultate, rezultate koji su u vezi sa pitanjima životne sredine. Za svaku kategoriju uticaja postoje odgovarajući indikatori i koristi se karakterističan model za dobijanje rezultata. U slučaju CFP studije, utvrđuje se ugljenični otisak proizvoda prema fazama životnog ciklusa i po izvorima emisija. Izvori emisije i faktori karakterizacije određeni su na osnovu odabrane metode karakterizacije.

Metoda karakterizacije (metoda procene uticaja) - predstavlja metodu na osnovu koje se radi proračun uticaja na životnu sredinu. Naime, različite metode karakterizacije definišu različite kategorije uticaja/izvore emisija, pa tako npr. IPCC 2021 100a, koja se koristi za CFP studiju, definiše 4 izvora emisija: fosilne, biogene izvore emisija, emisije iz direktne promene namene zemljišta, kao i CO_2 uptake („skladištenje" CO_2), koji su svi predstavljeni u istoj jedinici (kg CO_{2e}). Emisije iz ovih izvora po svakom proizvodu se sabiraju, kako bi se dobio konačan rezultat ugljeničnog otiska proizvoda.

Dakle, u fazi ocenjivanja uticaja životnog ciklusa, donose se zaključci koji omogućavaju donošenje boljih poslovnih odluka, klasifikuju se uticaji na životnu sredinu svih procesa prikupljenih i modelovanih u inventaru životnog ciklusa, a koji se potom prevode u teme životne sredine kao što su, na primer, globalno zagrevanje ili zdravlje ljudi.

III Impact assessment phase

The impact assessment phase or LCIA (Life Cycle Impact Assessment) is carried out through the establishment of relationships - the connection of inputs and outputs with environmental impacts. Therefore, this phase provides information for the interpretation phase and provides a comprehensive overview of the issue of the impact of products or services on the environment and resources.

In this phase, the results of the LCI phase are sorted into specifically selected impact categories. Impact categories are used for specific results, results that are related to environmental issues. For each category of impact there are corresponding indicators and a characteristic model is used to obtain results. In the case of the CFP study, the carbon footprint of the product is determined by life cycle stages and by emission sources. Emission sources and characterization factors are determined based on the chosen characterization method.

Characterization method (method of impact assessment) - represents the method based on which the calculation of the impact on the environment is carried out. Namely, different methods of characterization define different categories of impacts/sources of emissions, so for example IPCC 2021 100a, which is used for the CFP study, defines 4 sources of emissions: fossil, biogenic sources of emissions, emissions from direct land-use change, as well as CO_2 uptake („storage" of CO_2), which are all presented in the same unit (kg CO_{2e}). Emissions from these sources for each product are added together to obtain the final result of the product's carbon footprint.

Therefore, in the life cycle impact assessment phase, conclusions are drawn that enable better business decisions to be made, the environmental impacts of all processes collected and modeled in the life cycle inventory are classified, which are then translated into environmental topics such as, for example, global warming or human health.

IV Faza interpretacije rezultata

Interpretacija rezultata ocenjivanja životnog ciklusa je poslednji korak i ona uključuje potvrđivanje zaključaka do kojih se došlo u fazi procene uticaja životnog ciklusa i osiguravanje da su prikazani rezultati usklađeni sa standardom ISO 14044. Standard nudi niz „provera" koje pomažu da se potvrdi da li su zaključci potkrepljeni prikupljenim podacima i primenjenim metodologijama. Interpretacija se odvija u pet koraka, i to kroz: proveru kompletnosti, proveru doslednosti, proveru osetljivosti, identifikaciju značajnih pitanja i konačne zaključke, ograničenja i preporuke. Neophodno je biti siguran da su svi prikupljeni podaci tačni, da se pravilno mere i analiziraju, tako da se tek nakon toga mogu dati preporuke.

Ocenjivanje životnog ciklusa s obzirom na svestranost i upotrebljivost koja se ponavlja, predstavlja vrednu investiciju za kompanije koje su iskreno posvećene smanjenju svog uticaja na životnu sredinu.

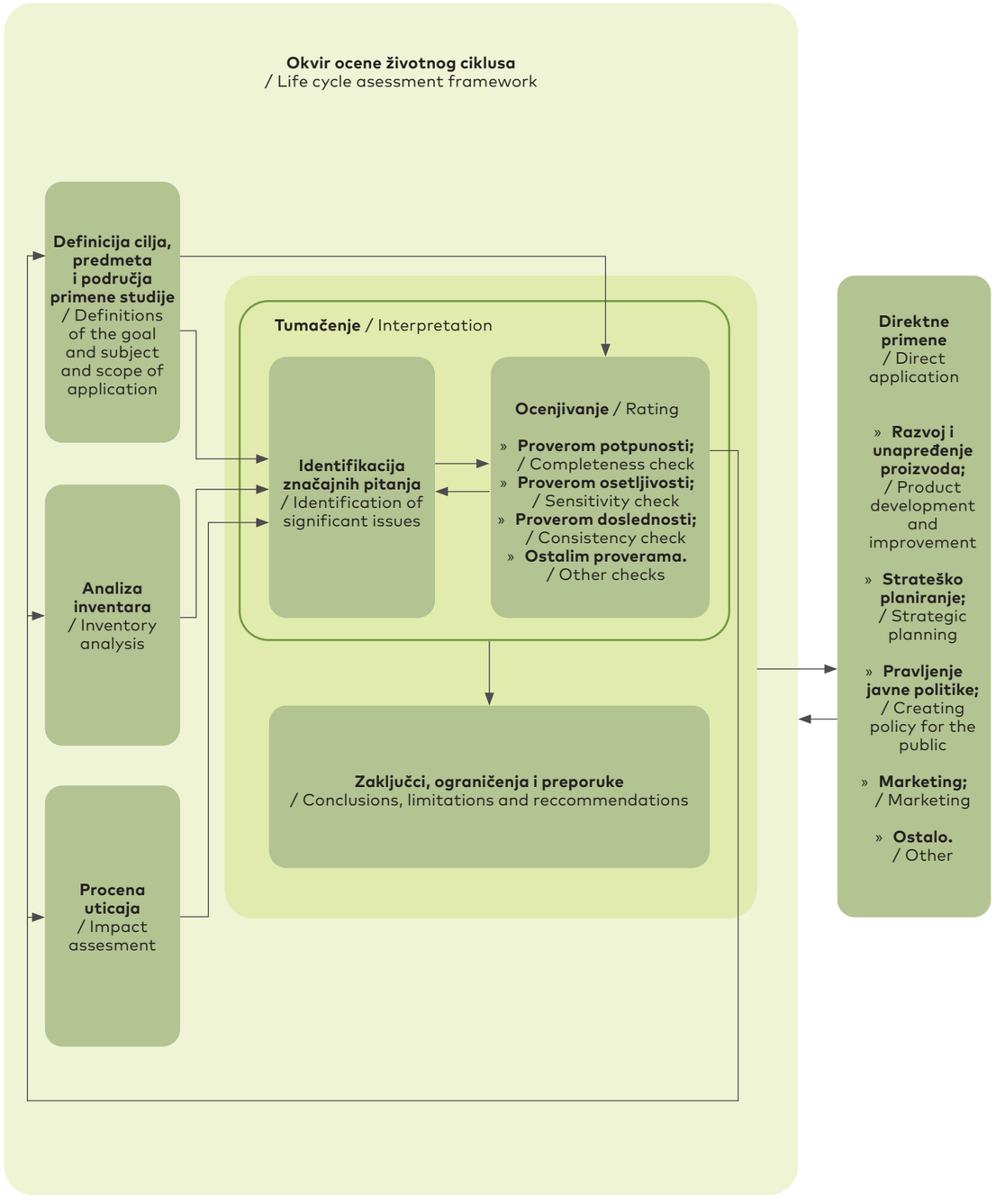
Jedinstven metod ocenjivanja životnog ciklusa, rigorozno je i čvrsto utemeljen na podacima, te zahvaljujući globalnoj standardizaciji, ovaj metod služi kao alat za isporuku transparentnih, proverljivih podataka o uticaju kompanije na životnu sredinu. Univerzalna primena standarda vezanih za životni ciklus obezbeđuje jednake uslove za procenu životne sredine u svim industrijama i granicama.

IV Results interpretation phase

The interpretation of the results of the life cycle assessment is the final step and it involves validating the conclusions reached in the life cycle impact assessment phase and ensuring that the presented results comply with the ISO 14044 standard. The standard offers a series of „checks" to help confirm that the conclusions supported by collected data and applied methodologies. The interpretation takes place in five steps, through: completeness check, consistency check, sensitivity check, identification of significant issues and final conclusions, limitations and recommendations. It is necessary to be sure that all collected data is correct, that it is properly measured and analyzed, so that recommendations can only be made after that.

Life cycle assessment for versatility and repeatable usability is a worthwhile investment for companies that are genuinely committed to reducing their environmental impact.

A unique method of life cycle assessment, it is rigorously and firmly based on data, and thanks to global standardization, this method serves as a tool for delivering transparent, verifiable data about the company's impact on the environment. The universal application of life cycle standards provides equal conditions for environmental assessment across industries and borders.



Ugljenični otisak proizvoda
Carbon footprint of the product

Ugljenični otisak proizvoda predstavlja zbir emisija i uklanjanja GHG u proizvodnom sistemu, izražen preko CO_{2e} (ugljen-dioksid ekvivalent). Njegova kvantifikacija pomaže kompanijama i pojedincima da bolje razumeju i smanje uticaj proizvoda na klimatske promene, identifikujući oblasti gde mogu smanjiti emisije tokom čitavog životnog ciklusa proizvoda. Ovo je važno u nastojanju da se smanji ukupna globalna emisija gasova sa efektom staklene bašte i usmeri prema održivijem i manje štetnom načinu proizvodnje i potrošnje.

The carbon footprint of a product represents the sum of GHG emissions and removals in the production system, expressed through CO_{2e} (carbon dioxide equivalent). Its quantification helps companies and individuals better understand and reduce the impact of products on climate change, identifying areas where they can reduce emissions throughout the product's life cycle. This is important in the effort to reduce the total global emission of greenhouse gases and move towards a more sustainable and less harmful way of production and consumption.

Standard ISO 14067 je zasnovan na principima ocenjivanja životnog ciklusa koji su dati u ISO 14040 i ISO 14044. Perspektiva LCA – kvantifikacija CFP uzima u razmatranje celokupan ciklus proizvoda, uključujući nabavku sirovina, projektovanje, proizvodnju, transport/isporuku, korišćenje i tretman na kraju životnog veka.

Studija CFP uključuje takođe četiri faze ocenjivanja životnog ciklusa:

I. Faza definicije cilja i predmeta i područja primene,

II. Faza analize inventara (LCI),

III. Faza ocenjivanja uticaja (LCIA) i

IV. Faza interpretacije životnog ciklusa za CFP ili delimični CFP.

Emisije i uklanjanje GHG iz životnog ciklusa proizvoda moraju se dodeliti fazi životnog ciklusa u kojoj dolazi do emisije i uklanjanja GHG. Delimični CFP može se dodati zajedno da bi se kvantifikovao CFP, ali pod uslovom da se izvode po istoj metodologiji, za isti vremenski period i da ne postoje preklapanja.

I. Cilj sprovođenja CFP studije jeste da se izračuna potencijalni doprinos proizvoda globalnom zagrevanju izraženom kao CO_{2e}, kvantifikovanjem svih značajnih emisija i uklanjanja GHG tokom životnog ciklusa proizvoda ili izabranih procesa u skladu sa kriterijumima isključenja. Predmet i područje primene CFP studije moraju biti definisani u skladu sa ciljem.

Studija CFP mora jasno odrediti funkcionalnu ili deklarisanu jedinicu sistema koja je predmet proučavanja. Primarna svrha funkcionalne i/ili deklarisane jedinice je da pruži referencu na koju se odnose ulazni i izlazni elementi, tako da jedinica mora da bude jasno definisana i merljiva. Funkcionalna jedinica jeste kvantifikovana performansa proizvodnog sistema koja se koristi u formi njegove jedinice, veličine i – ako je relevantno – trajanja i nivoa kvaliteta. Deklarisana jedinica je količina proizvoda koja se koristi kao referentna jedinica u kvantifikaciji delimičnog CFP, odnosno koristi se kada LCA ne pokriva ceo životni ciklus proizvoda. Nakon odabira funkcionalne ili deklarisane jedinice, definiše se referentni tok (mera ulaza i izlaza neophodnih da se ispuni funkcija opisana funkcionalnom jedinicom).

The ISO 14067 standard is based on the principles of life cycle assessment given in ISO 14040 and ISO 14044. The LCA perspective - CFP quantification considers the entire product cycle, including raw material acquisition, design, production, transport/delivery, use and end-of-life treatment.

The CFP study also includes four life cycle assessment phases:

I. Phase of definition of the goal and subject and scope of application,

II. Inventory Analysis Phase (LCI),

III. Impact Assessment Phase (LCIA) and

IV. Interpretation phase of the life cycle for CFP or partial CFP.

GHG emissions and removals from a product's life cycle must be assigned to the stage of the life cycle in which GHG emissions and removals occur. Partial CFP can be added together to quantify the CFP, but provided that they are derived using the same methodology, for the same time period, and that there are no overlaps.

I. The goal of conducting the CFP study is to calculate the potential contribution of the product to global warming expressed as CO_{2e}, by quantifying all significant emissions and removal of GHG during the life cycle of the product or selected processes in accordance with the exclusion criteria. The subject and field of application of the CFP study must be defined in accordance with the goal.

The CFP study must clearly define the functional or declared unit of the system that is the subject of the study. The primary purpose of a functional and/or declared unit is to provide a reference to which input and output elements refer, so the unit must be clearly defined and measurable. Functional unit is a quantified performance of a production system that is used in the form of its unit, size and - if relevant - duration and quality level. The declared unit is the quantity of the product that is used as a reference unit in the quantification of the partial CFP, i.e. it is used when the LCA does not cover the entire life cycle of the product. After selecting a functional or declared unit, a reference flow is defined (a measure of inputs and outputs necessary to fulfill the function described by the functional unit).

II. Analiza inventara životnog ciklusa LCI za CFP studiju se sastoji od sledećih koraka: prikupljanja i validacije podataka, povezivanja podataka sa jediničnim procesom i funkcionalnom ili deklarisanom jedinicom, podešavanje granica sistema i alokacije.

Kvalitativni i kvantitativni podaci za uključivanje u inventar životnog ciklusa moraju se prikupljati za sve jedinične procese koji su obuhvaćeni sistemom koji je predmet studije. Prikupljeni podaci se koriste za kvantifikovanje ulaznih i izlaznih elemenata za jedinični proces. Tokom postupka prikupljanja podataka mora se vršiti provera validnosti podataka kako bi se potvrdio i pružio dokaz da su ispunjeni zahtevi za kvalitet podataka. Validacija treba da uključuje uspostavljanje masenog bilansa, energetskog bilansa i/ili uporedne analize emisionih faktora ili drugih odgovarajućih metoda.

Naglašavamo, kao i kod LCA studije, potrebno je pažljivo prikupljati ulazne i izlazne podatke u sistemu proizvoda. Nivo agregacije mora biti u skladu sa ciljem CFP studije. Kvantifikacija koja je izvršena u skladu sa ISO 14067 mora da uključuje sve emisije i uklanjanja GHG onih jediničnih procesa koji su deo sistema proizvoda koji imaju potencijal da značajno doprinesu CFP ili delimičnom CFP. Studija CFP treba da koristi podatke koji smanjuju pristrasnost i nesigurnost koliko je praktično moguće, i to korišćenjem najkvalitetnijih dostupnih podataka.

Vremenski period za koji je CFP reprezentativan mora se specificirati i obrazložiti. Kada se emisije i uklanjanja GHG povezani sa specifičnim jediničnim procesima u toku životnog ciklusa proizvoda razlikuju tokom vremena, tada se podaci moraju prikupljati tokom vremenskog perioda koji je prikladan za utvrđivanje prosečnih emisija i uklanjanja GHG povezanih sa životnim ciklusom proizvoda. Svaka aktivnost koja se dogodi van tog perioda takođe mora biti uključena, pod uslovom da je unutar sistema proizvoda.

Podaci o emisijama i uklanjanju GHG moraju se odnositi na funkcionalnu ili deklarisanu jedinicu. Ukoliko je faza korišćenja uključena u predmet CFP studije, tada moraju biti uključene emisije i uklanjanja GHG koje proizilaze iz faze korišćenja proizvoda. Korisnik proizvoda i profil korišćenja proizvoda tada moraju biti specificirani u CFP studiji. Faza korišćenja počinje kada specificirani korisnik preuzme posedovanje gotovog proizvoda i završava se kada je prozvod spreman za odlaganje, ponovnu upotrebu za drugu funkciju, recikliranje ili za iskorišćenje u energetske svrhe.

II. LCI life cycle inventory analysis for the CFP study consists of the following steps: data collection and validation, linking data to unit process and functional or declared unit, setting system boundaries and allocation.

Qualitative and quantitative data for inclusion in the life cycle inventory must be collected for all unit processes that are included in the system under study. The collected data is used to quantify the input and output elements for the unit process. During the data collection process, a data validity check must be performed to confirm and provide evidence that the data quality requirements have been met. Validation should include establishment of mass balance, energy balance and/or comparative analysis of emission factors or other appropriate methods.

We emphasize, as with the LCA study, it is necessary to carefully collect input and output data in the product system. The level of aggregation must be consistent with the objective of the CFP study. The quantification performed in accordance with ISO 14067 must include all GHG emissions and removals of those unit processes that are part of the product system that have the potential to contribute significantly to CFP or partial CFP. The CFP study should use data that reduce bias and uncertainty as much as is practically possible, using the highest quality data available.

The time period for which the CFP is representative must be specified and justified. When the GHG emissions and removals associated with specific unit processes during the life cycle of a product vary over time, then data must be collected over a time period appropriate to determine the average GHG emissions and removals associated with the product life cycle. Any activity that occurs outside of that period must also be included, provided it is within the product system.

Data on GHG emissions and removals must refer to a functional or declared unit. If the use phase is included in the subject of the CFP study, then the GHG emissions and removals resulting from the use phase of the product must be included. The product user and product usage profile must then be specified in the CFP study. The use phase begins when the specified user takes possession of the finished product and ends when the product is ready for disposal, re-use for another function, recycling or energy recovery.

III. U fazi procene uticaja životnog ciklusa proizvoda CFP studije, potencijalni uticaj klimatskih promena svakog GHG koji se emituje i uklanja putem sistema proizvoda mora se izračunavati množenjem mase GHG ispuštenog ili uklonjenog sa stogodišnjim potencijalom globalnog zagrevanja, GWP (Global Warming Potential), datim od strane IPCC u jedinicama kg CO_{2e} po kg emisije.

IV. Faza tumačenja životnog ciklusa CFP studije mora se sastojati od identifikovanja značajnih pitanja na osnovu rezultata kvantifikacije CFP i delimičnog CFP u skladu sa inventarom životnog ciklusa, LCI (Life Cycle Inventory), i procenom uticaja na životni ciklus, LCIA (Life Cycle Impact Assessment), vrednovanja koje razmatra kompletnost, konzistentnost i analizu osetljivosti i formulisanja zaključaka, ograničenja i preporuka. Tumačenje treba da uključuje:

- analizu osetljivosti značajnih ulaznih i izlaznih elemenata i metodoloških izbora, uključujući procedure alokacije, kako bi se razumele osetljivosti i nesigurnosti rezultata;
- ocenjivanje uticaja profila alternativne upotrebe na konačan rezultat;
- ocenjivanje uticaja različitih scenarija kraja životnog veka na konačan rezultat;
- ocenjivanje posledica preporuka na konačan rezultat.

Rezultati o kojima se izveštava u CFP studiji mogu se koristiti u komunikacijama sa partnerima, odnosno uopšteno sa zainteresovanim stranama. Zaključci dati u CFP studije takođe moraju biti dokumentovani u izveštaju o CFP studiji bez pristrasnosti. Dalje, rezultati, podaci, metode, pretpostavke i tumačenje životnog ciklusa moraju biti transparentni i predstavljeni sa dovoljno detalja da čitaocu omoguće razumevanje kompleksnosti i inherentnih kompromisa u CFP studiji. Konačno, rezultati kvantifikacije CFP ili delimičnog CFP moraju biti dokumentovani u izveštaju.

Dakle, izveštaj o CFP studiji obavezno mora da sadrži: funkcionalnu ili deklarisanu jedinicu i referentni tok, granicu sistema, listu važnih jediničnih procesa, informacije o prikupljanju podataka, listu razmatranih GHG, izabrane faktore karakterizacije, izabrane kriterijume isključenja, izabrane procedure alokacije, vreme emisija i uklanjanja GHG

III. In the product life cycle impact assessment phase of the CFP study, the potential climate change impact of each GHG emitted and removed through the product system must be calculated by multiplying the mass of GHG emitted or removed by the hundred-year global warming potential, GWP (Global Warming Potential), given by the IPCC in units of kg CO2e per kg emission.

IV. The life cycle interpretation phase of the CFP study must consist of identifying significant issues based on the results of CFP quantification and partial CFP in accordance with the life cycle inventory, LCI, and the life cycle impact assessment, LCIA, evaluation that considers completeness, consistency and sensitivity analysis and formulation of conclusions, limitations and recommendations. Interpretation should include:

- sensitivity analysis of significant input and output elements and methodological choices, including allocation procedures, in order to understand the sensitivities and uncertainties of the results;
- evaluating the impact of the alternative use profile on the final result;
- evaluating the impact of different end-of-life scenarios on the final result;
- evaluation of the consequences of the recommendations on the final result.

The results reported in the CFP study can be used in communications with partners, or in general with stakeholders. The conclusions reached in the CFP study must also be documented in an unbiased CFP study report. Further, results, data, methods, assumptions, and life cycle interpretation must be transparent and presented in sufficient detail to enable the reader to understand the complexities and inherent trade-offs in a CFP study. Finally, the results of CFP or partial CFP quantification must be documented in a report.

Therefore, the CFP study report must necessarily contain: functional or declared unit and reference flow, system boundary, list of important unit processes, information on data collection, list of considered GHGs, selected characterization factors, selected exclusion criteria, selected allocation procedures, time of emissions and GHG removals

(ako je primenjivo), opis podataka, rezultate analize osetljivosti i procene nesigurnosti, tretman električne energije, rezultate interpretacije LC sa zaključcima i ograničenjima, otkrivanje i opravdanje izbora vrednosti izvršenih u kontekstu odluka unutar CFP studije, predmet i područje primene sa opravdanjima i isključenjima, opis faza LC, procenu uticaja alternativnih profila korišćenja i kraj životnog veka na konačni rezultat.

Pored ISO 14067, postoje i drugi standardi koji daju kompanijama smernice i podržavaju kredibilitet metrike karbonskog otiska na tržištu:

- Nacionalni standardi kao što je PAS 2050, koji je razvijen od strane BSI (Britanski institut za standarde). Ovaj standard ima široku primenu i smatra se prvim standardom za karbonski otisak koji se koristi na međunarodnom nivou.
- Standard proizvoda GHG protokola je razvijen da bude u skladu sa prvom verzijom PAS 2050, s tim što Standard za proizvode GHG protokola uključuje zahteve za javno izveštavanje. GHG Protokol predstavlja standardizovani globalni okvir merenja i upravljanja emisijama gasova sa efektom staklene bašte u privatnom i javnom sektoru i pruža dodatne standarde za korporativne procene i proračune u vezi sa projektima.

(if applicable), description of data, results of sensitivity analysis and uncertainty assessment, treatment of electricity, results of LC interpretation with conclusions and limitations, disclosure and justification of value choices made in the context of decisions within the CFP study, subject and area of application with justifications and exclusions, description of LC phases, assessment of the impact of alternative usage profiles and end of life on the final result.

In addition to ISO 14067, there are other standards that provide companies with guidance and support the credibility of carbon footprint metrics in the marketplace:

- National standards such as PAS 2050, which was developed by BSI (British Standards Institute). This standard is widely used and is considered the first carbon footprint standard used internationally.
- The GHG Protocol Product Standard was developed to comply with the first version of PAS 2050, with the GHG Protocol Product Standard including public reporting requirements. The GHG Protocol represents a standardized global framework for measuring and managing greenhouse gas emissions in the private and public sectors and provides additional standards for corporate assessments and project-related calculations.

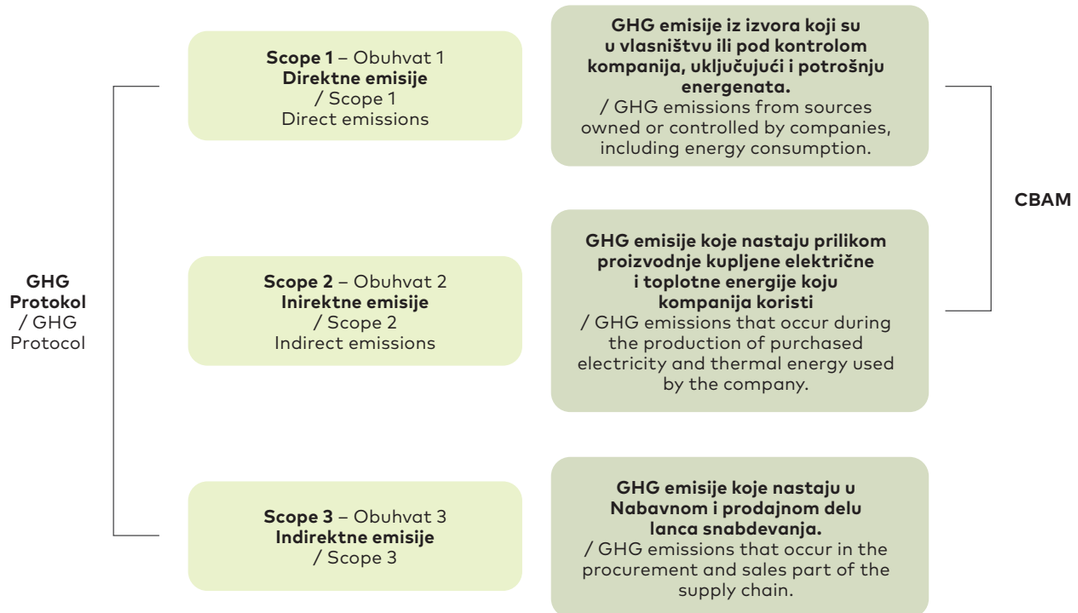


Tabela 1. Razlike pri izračunavanju CFP prema PAS 2050, GHG Protokolu i ISO 14067

Specifikacija i zahtevi		PAS 2050	GHG Protokol	ISO 14067
Ciljevi		Obezbediti jedinstvene specifikacije za emisije GHG dobara i usluga	Pružiti detaljne smernice o računovodstvu i izveštavanju	Utiče na kvalitet ambijentalnog vazduha
Uključena faza životnog ciklusa		Cradle-to-Grave	Cradle-to-Grave	Cradle-to-Grave
				Cradle-to-Gate
				Gate-to-Gate
		Cradle-to-Gate	Cradle-to-Gate	Delimičan životni ciklus
Kriterijum isključenja		Isključenja na osnovu materijalnosti (<1%); mora biti uključeno najmanje 95% celog životnog ciklusa proizvoda; nema potrebe za povećanjem za 100%	Ne postoje kriterijumi isključenja jer je neophodna 100% potpunost	Nema dostupnih specifičnih kriterijuma
Kapitalna dobra		Isključena	Isključena, ali ohrabrena da budu uključena kada je to relevantno	Isključena ako ne utiču bitno na ukupne zaključke
Biogeni ugljenik	Skladištenje ugljenika	Skladišteni ugljenik u roku od 100 godina biće evidentiran i obračunat u CF proračunima	Za sistem od kolevke do kapije, kredit se daje biogenom skladištenju ugljenika	Ako se izračunava skladištenje ugljenika, onda će to posebno prijaviti, ali neće biti uključeno u CF rezultat
	Odložene emisije	Faktor težine je uključen i predložen	Neće biti uključene	Biće uključene
Druga isključenja	Promena korišćenja zemljišta	Specifična procedura i obezbeđuje podrazumevane emisije iz zemljišta po državi	Pruža smernice za određivanje uticaja koji se mogu pripisati	Direktna promena namene zemljišta se posebno dokumentuje; treba razmotriti indirektnu promenu namene zemljišta
	Ostalo	Ostali izuzeci uključuju prevoz radnika do njihovog radnog mesta i potrošača do mesta kupovine, unos ljudske energije u proces i životinje koje pružaju usluge transporta		
Alokacija		(1) Izbegavanje alokacije putem podele procesa ili proširenja granica sistema (2) Dopunski zahtevi (3) Ekonomska alokacija	(1) Izbegavanje alokacije podelom procesa i redefinisanje funkcionalne jedinice ili proširenja sistema (2) Fizički odnosi (3) Ekonomske ili druge metode alokacije	
Potencijal globalnog zagrevanja		100 godina		

Naša preporuka je da se pri izradi CFP studije vodite ISO 14067 standardom, a da ono što nije jasno definisano kao što je na primer cut-off kriterijumi preuzmete iz PAS standarda koji kaže da mora biti uključeno najmanje 95% celog životnog ciklusa proizvoda.

Table 1. Differences when calculating CFP according to PAS 2050, GHG Protocol and ISO 14067

Specification and requirements		PAS 2050	GHG Protocol	ISO 14067
Goals		Provide uniform specifications for GHG emissions of goods and services	Provide detailed guidance on accounting and reporting	Standardize the process of quantifying and communicating greenhouse emissions
Life cycle stage involved		Cradle-to-Grave	Cradle-to-Grave	Cradle-to-Grave
				Cradle-to-Gate
				Gate-to-Gate
		Cradle-to-Gate	Cradle-to-Gate	Partial life cycle
Exclusion criteria		Exclusions based on materiality (<1%); at least 95% of the product's entire life cycle must be involved; no need to increase by 100%	There are no exclusion criteria as 100% completeness is required	No specific criteria available
Capital assets		Excluded	Excluded, but encouraged to be included when relevant	Excluded if they do not significantly affect the overall conclusions
Biogenic carbon	Carbon storage	The stored carbon within 100 years will be recorded and calculated in CF calculations	For a cradle-to-gate system, credit is given to biogenic carbon storage	If carbon storage is being calculated then this will be reported separately but will not be included in the CF result
	Delayed emissions	A mass factor is included and suggested	They will not be included	They will be included
Other exclusions	Change of land use	The specific procedure also provides default emissions from land by country	Provides guidance for determining attributable impacts	Direct change of land use is separately documented; indirect land use change should be considered
	Other	Other exceptions include the transportation of workers to their workplace and consumers to their point of purchase, the input of human energy into the process, and animals that provide transportation services		
Allocation		(1) Avoiding allocation through process splitting or system boundary expansion (2) Additional requirements (3) Economic allocation	(1) Avoiding allocation by dividing the process and redefining the functional unit or system extension (2) Physical relations (3) Economic or other allocation methods	
Global warming potential		100 years		

Our recommendation is to follow the ISO 14067 standard when preparing the CFP study, and to take what is not clearly defined, such as the cut-off criteria, from the PAS standard, which states that at least 95% of the product's entire life cycle must be included.

Elixir Group je vodeći proizvođač fosforne kiseline u regionu i najveći proizvođač kompleksnih mineralnih đubriva na Balkanu. Ulaganjem u znanje i usavršavanje zaposlenih ova kompanija odgovorno i održivo posluje na tržištu već 33 godine i globalno je prepoznata po kvalitetu proizvoda i usluga. Svesni činjenice da održivi razvoj ne predstavlja samo zaštitu životne sredine ili klime, već podrazumeva pristup pri kome se ekološka, ekonomska i socijalna pitanja tretiraju ravnopravno i posmatraju kao međusobno povezane i zavisne, Elixir Group pored investicija u postojeće i inovativne tehnologije, pruža podršku zajednicama u kojima posluje i brojnim aktivnostima doprinosi njihovom održivom razvoju.

Poslovni sistem čini 12 kompanija članica koje međusobno kolaboriraju sa više od 1.800 zaposlenih. Da su ljudi u ovoj kompaniji prepoznati kao najveća snaga i kapital potvrđuje stabilan i posvećen tim iskusnih profesionalaca i konstantan priliv mladih talenata.

Ostvarujući svoju viziju da „stvara nasleđe kroz održivi razvoj na dobrobit zajednice i uspeh svakog pojedinca“, Elixir Group se u svakom segmentu svog poslovanja rukovodi Ciljevima održivog razvoja SDG's (Sustainable development goals), koji su obuhvaćeni Agendom 2030. Posvećeni su globalnim i regionalnim ciljevima održivog razvoja, dekarbonizaciji proizvodnih i poslovnih procesa i kontinuiranim unapređenjima resursne i tehnološke efikasnosti.

U cilju određivanja uticaja proizvoda na životnu sredinu rađena je analiza životnog ciklusa proizvodnog programa Elixir Group:

Elixir Group is the leading producer of phosphoric acid in the region and the largest producer of complex mineral fertilizers in the Balkans. By investing in the knowledge and training of its employees, this company has been operating responsibly and sustainably on the market for 33 years and is globally recognized for the quality of its products and services. Aware of the fact that sustainable development does not only represent the protection of the environment or the climate, but implies an approach in which environmental, economic and social issues are treated equally and viewed as interrelated and dependent, Elixir Group, in addition to investments in existing and innovative technologies, provides support to communities in with which it operates and contributes to their sustainable development with numerous activities.

The business system consists of 12 member companies that collaborate with each other with more than 1,800 employees. That the people in this company are recognized as the greatest strength and asset is confirmed by a stable and dedicated team of experienced professionals and a constant influx of young talents.

Realizing its vision to „create the legacy through sustainable development for the benefit of the community and the success of each individual“, Elixir Group is guided in every segment of its business by the SDG's (Sustainable development goals), which are included in the 2030 Agenda. They are committed to global and regional goals, sustainable development, decarbonization of production and business processes and continuous improvements of resource and technological efficiency.

In order to determine the impact of the product on the environment, an analysis of the life cycle of the Elixir Group production program was carried out:

Kompleksna mineralna đubriva koja se proizvode u fabrikama Elixir Zorka i Elixir Prahovo sadrže sve potrebne makroelemente i mikroelemente potrebne za pravilan razvoj biljke:

The complex mineral fertilizers produced in Elixir Zorka and Elixir Prahovo factories contain all the necessary macroelements and microelements needed for proper plant development:

- Kompleksna mineralna đubriva iz **Elixir BASIC** linije odlikuje visoka koncentracija hranljivih elemenata, prisustvo ključnih makroelemenata i ujednačena granulacija. Svaka granula ima isti hemijski sastav, a zbog oblika aktivne materije karakteriše ih visok stepen vodorastvorljivosti. Primenom formulacija iz Basic linije omogućava se gajenim kulturama brz, ujednačen porast i veća fizička stabilnost useva. Takve biljke su mnogo tolerantnije na nepovoljne klimatske uticaje, ostvaruju veće, stabilnije prinose i obezbeđuju sigurnost u poljoprivrednoj proizvodnji.
- **Elixir PREMIUM** linija obuhvata formulacije čiji je sadržaj posebno obogaćen sekundarnim makro i mikroelementima sa ciljem da se biljci obezbede svi neophodni nutrijenti za efikasniji i nesmetani rast i razvoj, a samim tim i veći i kvalitetniji prinos. Mikroelementi su u sulfatnom obliku, visoko su vodorastvorljivi, i lako dostupni biljkama, a dopunjuju uticaj na rast i razvoj biljaka koje pružaju primarni i sekundarni makroelementi.

- Complex mineral fertilizers from the **Elixir BASIC** line are characterized by a high concentration of nutrients, the presence of key macroelements and uniform granulation. Each granule has the same chemical composition, and due to the form of the active substance, they are characterized by a high degree of water solubility. By applying the formulations from the Basic line, fast, uniform growth and greater physical stability of the crops are enabled for cultivated crops. Such plants are much more tolerant to adverse climatic influences, achieve higher, more stable yields and ensure safety in agricultural production.
- **Elixir PREMIUM** line includes formulations whose content is specially enriched with secondary macro and microelements with the aim of providing the plant with all the necessary nutrients for more efficient and unhindered growth and development, and therefore a higher and better yield. Microelements are in sulfate form, highly water-soluble, and easily available to plants, and complement the influence on plant growth and development provided by primary and secondary macroelements.

- **Elixir MICRO GRAN** linija proizvoda obuhvata mikrogranulisana kompleksna mineralna đubriva razvijena korišćenjem najnovijih tehnologija dimenzija 0,5-1,2 mm. Mikrogranulisana startna đubriva imaju dobro izbalansiran odnos hranljivih materija: primarnih, sekundarnih i esencijalnih mikroelemenata, koji stimulišu rast biljaka u početnim fazama razvoja i doprinose boljem ukorenjavanju biljke. Cilj upotrebe mikrogranulisanih đubriva je preciznije doziranje i distribucija mineralnog đubriva radi efikasnijeg iskorišćavanja hraniva od strane biljaka.
- U želji da različitim tržištima ponudi najbolje rešenje kako za specifične biljne kulture tako i za sve tipove zemljišta, razvojni tim Elixir Zorka kreirao je **Elixir SUPREME** liniju proizvoda. Elixir SUPREME linija obuhvata kompleksna mineralna đubriva koja su obogaćena mikroelementima i namenjena su najzahtevnijim biljnim kulturama. Ono što Supreme liniju proizvoda razlikuje od ostalih proizvodnih linija, jeste kalijum (K) koji se u većini formulacija nalazi u sulfatnoj formi (SOP). SUPREME linija se razvija u skladu sa zahtevima brojnih kupaca na globalnom tržištu.

Fosforna kiselina je strateški proizvod Elixir Prahovo. Sopstvena proizvodnja fosforne kiseline kao osnovne sirovinske komponente za proizvodnju visokokvalitetnih mineralnih đubriva, ujedno predstavlja ključ uspeha Elixir Prahovo i definiše budući razvoj kompanije. Investicioni planovi Elixir Prahovo usmereni su na povećanje kapaciteta proizvodnje fosforne kiseline, više faze prečišćavanja fosforne kiseline, proizvodnju kristalnih i tečnih đubriva, kao i fosfatnih soli feed, tehničkog i food kvaliteta.

AlumoFluor (AlF3) je je aluminijum-fluorid niske gustine koji sadrži min. 96 % aktivne supstance. Koristi se kao katalizator u proizvodnim procesima industrije aluminijuma, gde zajedno sa kriolitom povećava provodljivost elektrolita rastvora, smanjujući potrošnju električne energije i ukupne troškove proizvodnje aluminijuma. Osnovna sirovina za proizvodnju AlumoFluora se dobija kao nusproizvod pri proizvodnji koncentrovane fosforne kiseline, tako da ova proizvodnja za Elixir Prahovo, pored ekonomskog ima i ekološki značaj.

- **Elixir MICRO GRAN** product line includes microgranulated complex mineral fertilizers developed using the latest technologies with dimensions of 0.5-1.2 mm. Microgranulated starter fertilizers have a well-balanced ratio of nutrients: primary, secondary and essential microelements, which stimulate plant growth in the initial stages of development and contribute to better plant rooting. The goal of using microgranulated fertilizers is more precise dosing and distribution of mineral fertilizers for more efficient use of nutrients by plants.
- In the desire to offer different markets the best solution both for specific plant crops and for all types of soil, the Elixir Zorka development team created the **Elixir SUPREME** product line. The Elixir SUPREME line includes complex mineral fertilizers that are enriched with microelements and are intended for the most demanding plant crops. What distinguishes the Supreme product line from other product lines is potassium (K), which is found in sulfate form (SOP) in most formulations. The SUPREME line is being developed in accordance with the requirements of numerous customers on the global market

Phosphoric acid is a strategic product of Elixir Prahovo. Own production of phosphoric acid as the basic raw material component for the production of high-quality mineral fertilizers is also the key to the success of Elixir Prahovo and defines the future development of the company. The investment plans of Elixir Prahovo are aimed at increasing the production capacity of phosphoric acid, multiple stages of purification of phosphoric acid, production of crystalline and liquid fertilizers, as well as phosphate salts of feed, technical and food grade.

AlumoFluor (AlF3) is a low-density aluminum fluoride that contains min. 96% of the active substance. It is used as a catalyst in the production processes of the aluminum industry, where, together with cryolite, it increases the conductivity of the electrolyte solution, reducing the consumption of electricity and the overall costs of aluminum production. The basic raw material for the production of AlumoFluor is obtained as a by-product during the production of concentrated phosphoric acid, so this production for Elixir Prahovo has, in addition to economic, ecological significance.

Analiza životnog ciklusa pomoću softverskog rešenja

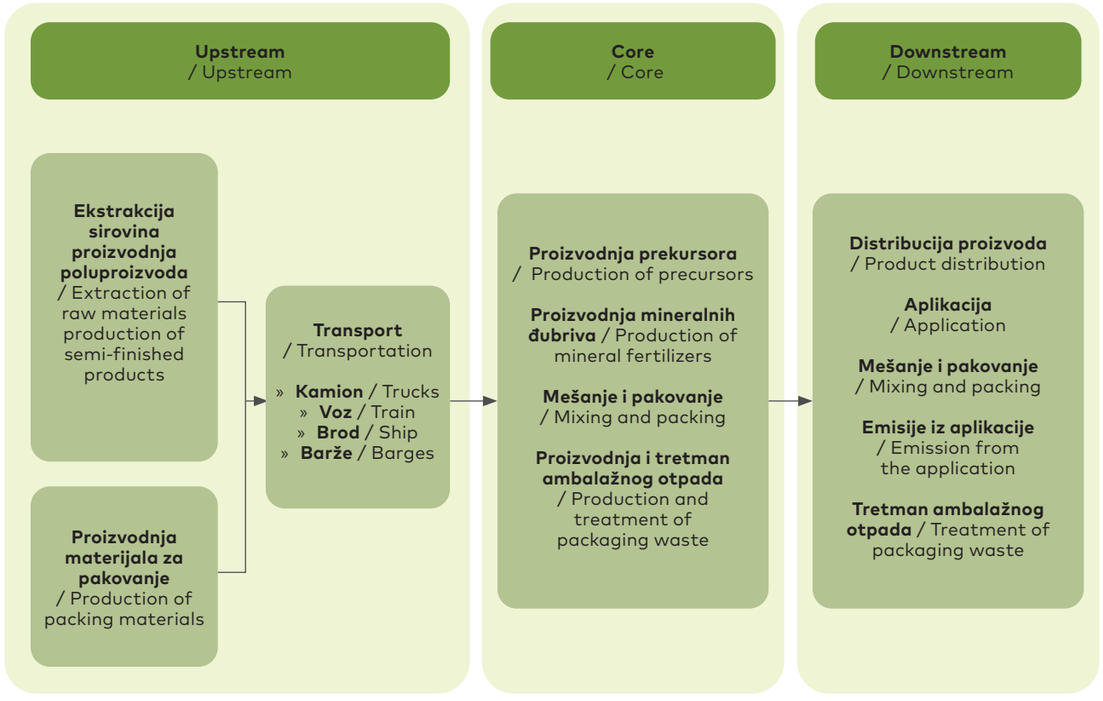
Life cycle analysis using a software solution

Za potrebe izrade ove studije korišćen je SimaPro, vodeći svetski softver za procenu životnog ciklusa, koji se koristi u industriji i naučnim institucijama u više od 80 zemalja. Relativno je jednostavan za upotrebu, kao i većina drugih sličnih alata, omogućava korisnicima da grade složene modele životnog ciklusa proizvoda na transparentan način koristeći poznate ecoinvent baze podataka. Sadrži 17 različitih načina (metoda) za procene uticaja na životnu sredinu. Program se zasniva na relacionim bazama podataka koje obuhvataju: bazu procesa, bazu metoda, bazu supstanci, bazu otpadnih frakcija i bazu konverzije jedinica i veličina.

Prvi korak u izradi analize je napraviti procesni dijagram kompletnog životnog ciklusa:

SimaPro, the world's leading life cycle assessment software, used in industry and scientific institutions in more than 80 countries, was used for this study. It is relatively easy to use, like most other similar tools, it allows users to build complex product life cycle models in a transparent way using the famous ecoinvent databases. It contains 17 different ways (methods) for environmental impact assessments. The program is based on relational databases that include: process database, method database, substance database, waste fraction database and unit and size conversion database.

The first step in creating an analysis is to create a process diagram of the complete life cycle:



Primer za procesni dijagram kompletnog životnog ciklusa za NPK đubriva
Example of a complete life cycle process diagram for NPK fertilizers

Deklarisana jedinica definisana prema PCR je ista za sve proizvode uključene u studiji: jedna tona proizvoda.

Najzahtevniji deo procesa izrade LCA studije je prikupljanje i konsolidovanje svih neophodnih podataka za generisanje sopstvene baze u okviru SimaPro softvera. Preporuka je da se prilikom izrade studije koriste primarni podaci iako unutar softverskog rešenja postoji mogućnost korišćenja generičkih podataka.

Koraci koje potrebno uraditi da bi se generisala baza podataka koja je dovoljno informativna kako bi se uradila LCA analiza jesu:

1. Mapirati podatke koji su potrebni za LCA/CFP;
2. Mapirati koja služba u kompaniji ih koristi/zna;
3. Napraviti jasan upitnik i distribuirati ga kolegama ili po potrebi partnerima (dobavljačima).

Podaci o procesu proizvodnje dobijeni su od proizvodnog sektora kompanije. Oni su uključivali opis procesa proizvodnje, količinu i kvalitet ulaznih sirovina i vode, mesto gde ulaze u proces proizvodnje, način na koji sirovina dolazi do mesta gde se troši, da li se prilikom njene upotrebe generiše otpad i u kojoj količini (npr. ukoliko dolazi u vrećama ili u IBC kontejnerima i koji je dalji put tog opada), podatke o poluproizvodima, vrsti i količini energenata, vrsti i količini korišćenog ambalažnog materijala za konkretan proizvod i sve to u odnosu na deklarisanu jedinicu proizvoda.

Od sektora nabavke, a u saradnji sa dobavljačima, dobijeni su podaci o poreklu sirovine, njen bezbednosni list (iz njega je vidljivo o kojoj vrsti hemijske supstance se radi, šta sve sadrži ukoliko je reč o smeši, koju klasu opasnosti hemikalija nosi i CAS broj koji služi za lakšu pretragu hemikalije u bazi podataka), vrsti i načinu transporta, kao i informacije o koje gorivo transportno sredstvo koristi i rastojanju od proizvođača do proizvodne članice Elixir Group.

Od sektora interne logistike prikupljeni su podaci o internom transportu koji se odnosi na prevoz sirovina, poluproizvoda i proizvoda od hale sirovina do pogona za proizvodnju, odnosno od rinfuz proizvoda do mesta pakovanja gotovog proizvoda (načinu i vrsti transporta, rastojanju, vrsti goriva koji koristi prevozno sredstvo ili industrijska mehanizacija).

The declared unit defined according to PCR is the same for all products included in the study: one ton of product.

The most demanding part of the process of creating an LCA study is the collection and consolidation of all the necessary data to generate your own database within the SimaPro software. It is recommended that primary data be used when creating the study, although within the software solution there is the possibility of using generic data.

The steps that need to be taken in order to generate a database that is informative enough to perform an LCA analysis are:

1. Map the data needed for LCA/CFP;
2. Map which department in the company uses/knows them;
3. Create a clear questionnaire and distribute it to colleagues or, if necessary, partners (suppliers).

Data on the production process were obtained from the company's production sector. They included a description of the production process, the quantity and quality of incoming raw materials and water, the place where they enter the production process, the way in which the raw material reaches the place where it is consumed, whether waste is generated during its use and in what quantity (e.g. if it comes in bags or in IBC containers and which is the further path of that waste), data on semi-finished products, type and quantity of energy sources, type and quantity of packaging material used for a specific product and all this in relation to the declared unit of the product.

From the procurement sector, in cooperation with the suppliers, data was obtained on the origin of the raw material, its safety data sheet (it shows what type of chemical substance it is, what it contains if it is a mixture, what hazard class the chemical carries and the CAS number that serves for an easier search for a chemical in the database), type and method of transport, as well as information about the fuel used by the means of transport and the distance from the manufacturer to the production member of Elixir Group.

From the internal logistics sector, data was collected on internal transport related to the transport of raw materials, semi-finished products and products from the raw material hall to the production plant, i.e. from the bulk product to the place of packaging of the finished product (method and type of transport, distance, type of fuel used by the means of transport or industrial machinery).

Sektor kontrole kvaliteta dao je informacije o fizičkim i hemijskim osobinama sirovina i gotovog proizvoda. Ove informacije su od izuzetnog značaja, jer su nam one ključne za pretpostavku o eventualnim emisijama u životnu sredinu koje možemo očekivati.

Od EHS sektor dobijeni su podaci o monitoringu emisija u vazduh, zemljište i vodu, kao i o generisanju i tretmanu otpada na samoj lokaciji gde se vrši proizvodnja posmatranih proizvoda. Za emisije u vazduh korišćeni su podaci sa kontinualnih merača (CEMS) i rezultati periodičnih merenja koji su definisani prema IPPC dozvoli kada su u pitanju mineralna đubriva.

Po istom principu kao za Upstream i Core operacije, za Downstream operacije, kolege koje se bave prodajom mineralnih đubriva i fosforne kiseline su definisale transportne rute, vrste i načine transporta gotovog proizvoda od kapije do krajnjeg korisnika. Sa krajnjim korisnicima definisan je način aplikacije i tretman ambalaže nakon aplikacije gotovog proizvoda.

Nakon što su prikupljene sve informacije prelazi se na deo koji se tiče procene uticaja životnog ciklusa. U odeljku za podešavanje izračunavanja (Calculation setups) može se definisati koje životne cikluse, procese i (polu)proizvode je potrebno više puta analizirati i upoređivati. Prednost korišćenja ove opcije je u tome što se svi životni ciklusi ili (polu) proizvodi uvek pojavljuju istim redosledom, sa istim bojama i istom skalom.

Kada ste novi u programu SimaPro, preporučujemo da koristite LCA čarobnjak (engl. LCA Wizard) za podešavanje LCA projekta. Ovo će uštedeti mnogo vremena, a može da pomogne u razvoju složenih životnih ciklusa.

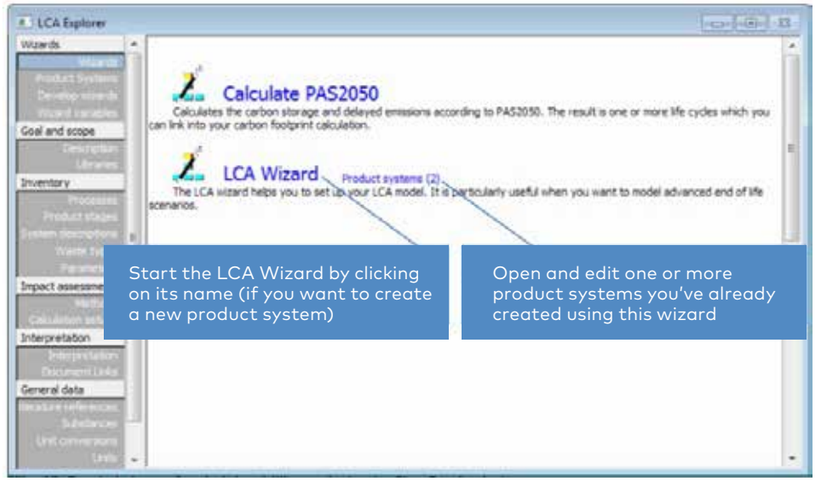
The quality control department provided information on the physical and chemical properties of the raw materials and the finished product. This information is extremely important, because it is crucial for us to make an assumption about possible emissions into the environment that we can expect.

Data were obtained from the EHS sector on the monitoring of emissions into the air, soil and water, as well as on the generation and treatment of waste at the very location where the observed products are produced. For emissions into the air, data from continuous meters (CEMS) and the results of periodic measurements were used, which were defined according to the IPPC permit when it comes to mineral fertilizers.

On the same principle as for Upstream and Core operations, for Downstream operations, colleagues dealing with the sale of mineral fertilizers and phosphoric acid defined transport routes, types and methods of transporting the finished product from the gate to the end user. The method of application and the treatment of the packaging after the application of the finished product were defined with the end users.

After all the information has been collected, we move on to the part concerning the life cycle impact assessment. In the Calculation setups section, it is possible to define which life cycles, processes and (semi)products need to be analyzed and compared multiple times. The advantage of using this option is that all life cycles or (semi)products always appear in the same order, with the same colors and the same scale.

When you are new to SimaPro, we recommend using the LCA Wizard to set up your LCA project. This will save a lot of time, and can help develop complex lifecycles.

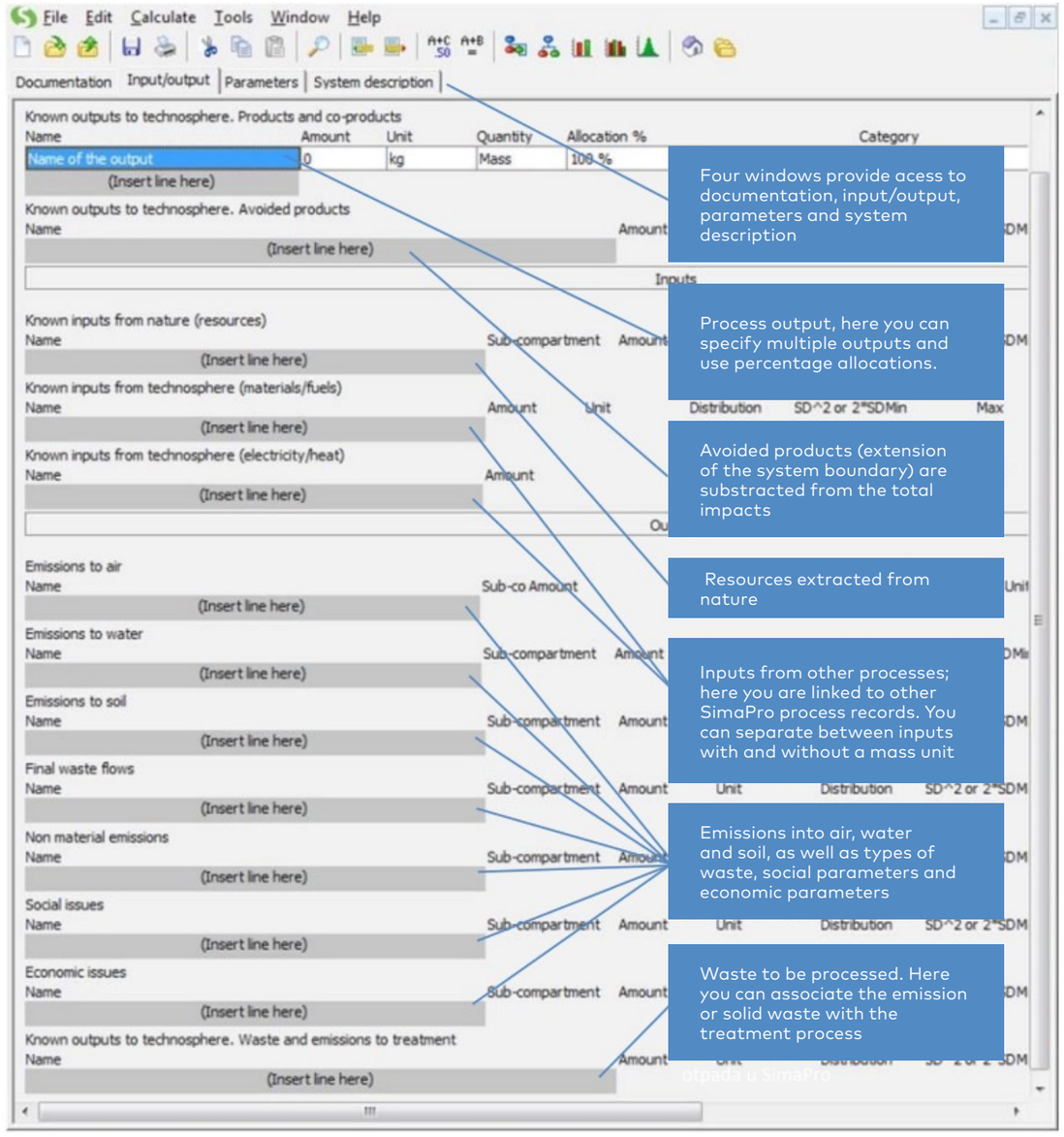


Kada se klikne na dugme „Set up your LCA Wizard", biće postavljeno niz pitanja. Potrebno je slediti uputstva i pružite odgovore na pitanja. Tokom ovog procesa može se videti kako će se struktura procesa razvijati u pozadini. Ova struktura se zasniva na odgovorima koji se daju i odražava činjenicu da je SimaPro koristio vaše podatke za razvoj novih entiteta u bazi podataka.

Parametri se mogu definisati na nivou procesa, projekta i baze podataka.

When the „Set up your LCA Wizard" button is clicked, a series of questions will be asked. You need to follow the instructions and provide answers to the questions. During this process, you can see how the process structure will develop in the background. This structure is based on the answers given and reflects the fact that SimaPro has used your data to develop new entities in the database.

Parameters can be defined at process, project and database level.



Prazan zapis procesa. Ovaj zapis procesa je osnovni gradivni blok za procesno stablo u Simapro softveru.
Empty process record. This process record is the basic building block for the process tree in Simapro software.

Konkretno, SimaPro softver uz pomoć naših inputa i EcoInvent baze radi obračun emisija za svaki pojedinačni input i na kraju ih sabira. Ako bismo posmatrali amonijak kao jednu od najznačajnih sirovina pri proizvodnji kompleksnih mineralnih đubriva (nosilac azotne komponente) proračun bi izgledao ovako:

- Transport: železnički transport, Dimitrovgrad-Šabac (rastojanje: 707 km) (u SimaPro birati za vrstu transporta (najbliža opcija realnoj): Transport, freight train {Europe without Switzerland}| diesel | Cut-off, U)
  - o Opterećenje kgCO_{2e}/km= 0,000056
  - o 707 km * 0,000056 kgCO2e/km = 0,039591 kgCO_{2e} /kg amonijaka
- Proizvodnja amonijaka: Ammonia, anhydrous, liquid {RER w/o RU}| ammonia production, steam reforming, liquid | Cut-off, U (BG RE mix) (za odabir se konsultovali sa proizvođačem amonijaka)
  - o Emisioni faktor za proizvodnju 1 kg amonijaka: 2,405869 kgCO2e
- Količina amonijaka koja se koristi za 1 t NPK 12:12:17 + 2 % MgO + 14 % S + 0,02 % B + 0,01 % Zn (SOP):
  - o 139,3 kg/1t NPK 12:12:17
  - ➜ Obračun emisije CO_{2e}:
  - o 139,3 kg * (0,039591+2,405869) = 340,6527 kg CO_{2e} /1t NPK 12:12:17

Miks električne energije koji je korišćen za proračun prilagođen je rezidualnom miksu u Srbiji na osnovu izveštaja AIB iz 2021. godine. Ovaj specifični miks je takođe modelovan prilagođavanjem Ecoinvent tržišnog proseka za visoki napon u Srbiji, koji je vezan za sve naredne procese sve do električne energije niskog napona. Odnos specifičnih tehnologija (po energentu) je uzet iz tržišnog proseka za Srbiju iz Ecoinvent-a, i prilagođen za ukupnu količinu električne energije po izvoru u rezidualnom miksu.

- Energija vetra 0,0 %
- Hidroenergija 28,1 %
- Lignit 68,3 %
- Prirodni gas 3,6 %

Drugi izvori energije, na primer, sagorevanje prirodnog gasa su direktne reference na Ecoinvent baze i Podataka koji su dostupni od dobavljača.

Procesi na kraju životnog veka (end-of-life) su ograničeni na tretman i odlaganje pakovanja (ambalaže) u kojem se proizvod isporučuje. Podaci o scenarijima prerade otpada su preuzeti od EuroStat-a.

Tretman otpada se modeluje do trenutka kada materijal dostigne status kraja otpada. Opterećenja i koristi izvan granica sistema se deklarišu zasebno.

In particular, the SimaPro software, with the help of our inputs and the EcoInvent database, calculates the emissions for each individual input and adds them up at the end. If we were to consider ammonia as one of the most important raw materials in the production of complex mineral fertilizers (nitrogen component carrier), the calculation would look like this:

- Transport: railway transport, Dimitrovgrad-Šabac (distance: 707 km) (in SimaPro select the type of transport (the closest option to the real one): Transport, freight train {Europe without Switzerland} | diesel | Cut-off, U)
  - o Load kgCO_{2e}/km= 0,000056
  - o 707 km * 0,000056 kgCO2e/km = 0,039591 kgCO_{2e} /kg ammonia
- Production of ammonia: Ammonia, anhydrous, liquid {RER w/o RU}| ammonia production, steam reforming, liquid | Cut-off, U (BG RE mix) (for selection consult the ammonia manufacturer)
  - o Emission factor for the production of 1 kg of ammonia: 2,405869 kgCO2e
- Amount of ammonia used for 1 t NPK 12:12:17 + 2 % MgO + 14 % S + 0,02 % B + 0,01 % Zn (SOP):
  - o 139,3 kg/1t NPK 12:12:17
  - ➜ Calculation of CO2e:
  - o 139,3 kg * (0,039591+2,405869) = 340,6527 kg CO_{2e} /1t NPK 12:12:17

The electric power mix used for the calculation was adjusted to the residual mix in Serbia based on the AIB report from 2021. This specific mix is also modeled by adjusting the Ecoinvent market average for high voltage in Serbia, which is related to all downstream processes up to low voltage electricity. The ratio of specific technologies (per energy source) was taken from the market average for Serbia from Ecoinvent, and adjusted for the total amount of electricity per source in the residual mix.

- Wind energy 0.0%
- Hydropower 28.1%
- Lignite 68.3%
- Natural gas 3.6%

Other sources of energy, for example, burning natural gas, are direct references to the Ecoinvent database and data available from suppliers.

End-of-life processes are limited to the treatment and disposal of the packaging in which the product is delivered. Data on waste processing scenarios were taken from EuroStat.

Waste treatment is modeled until the moment the material reaches end-of-waste status. Loads and benefits outside the system boundaries are declared separately.

End of life faza – Tretman i odlaganje otpada (C3-4) na osnovu podataka o otpadu Eurostat-a
End of life phase – Waste treatment and disposal (C3-4) based on Eurostat waste data

Grupe materijala	Ponovna upotreba	Reciklaža	Energetski oporavak	Spaljivanje	Deponija
Plastika	0%	0%	95%	0%	5%
Drvo	0%	0%	95%	0%	5%
Papir	0%	0%	95%	0%	5%
Paleta*	95%	0%	5%	0%	0%

* Bazirano na pretpostavci, s obzirom na to da statistički podaci nisu dostupni

Material groups	Reuse	Recycling	Energy recovery	Incineration	Landfill
Plastic	0%	0%	95%	0%	5%
Wood	0%	0%	95%	0%	5%
Paper	0%	0%	95%	0%	5%
Palette*	95%	0%	5%	0%	0%

* Based on an assumption, given that statistical data is not available

Transportne distance otpada do deponije, postrojenja za spaljivanje i reciklažu su preuzete od EeBGuide-a. Za transport do postrojenja za reciklažu, preporuka projekta EeBGuide je da se koristi prosečna udaljenost od 250 km kamionom. Ova distanca je naznačena u ovoj studiji, jer je do danas broj reciklažnih objekata još uvek mali.

- 50 km za deponiju;
- 100 km za spaljivanje;
- 250 km za reciklažu;
- 250 km za ponovnu upotrebu (pretpostavlja se da je isto kao i za reciklažu).

Imajući u vidu da je vrsta transporta nepoznata, sledeća referenca iz Ecoinvent baze podataka je korišćena za modelovanje transporta otpada: Transport, freight, lorry, unspecified {RER}| market for transport, freight, lorry, unspecified | Cut-off, U.

U SimaPro softveru interpretacija rezultata može biti dvojaka, pored numeričke vrednosti postoji mogućnost grafičkog prikaza.

Waste transport distances to landfill, incineration and recycling facilities are taken from EeBGuide. For transport to the recycling facility, the recommendation of the EeBGuide project is to use an average distance of 250 km by truck. This distance is indicated in this study, because to date the number of recycling facilities is still small.

- 50 km for the landfill;
- 100 km for Incineration;
- 250 km for recycling;
- 250 km for reuse (assumed to be the same as for recycling).

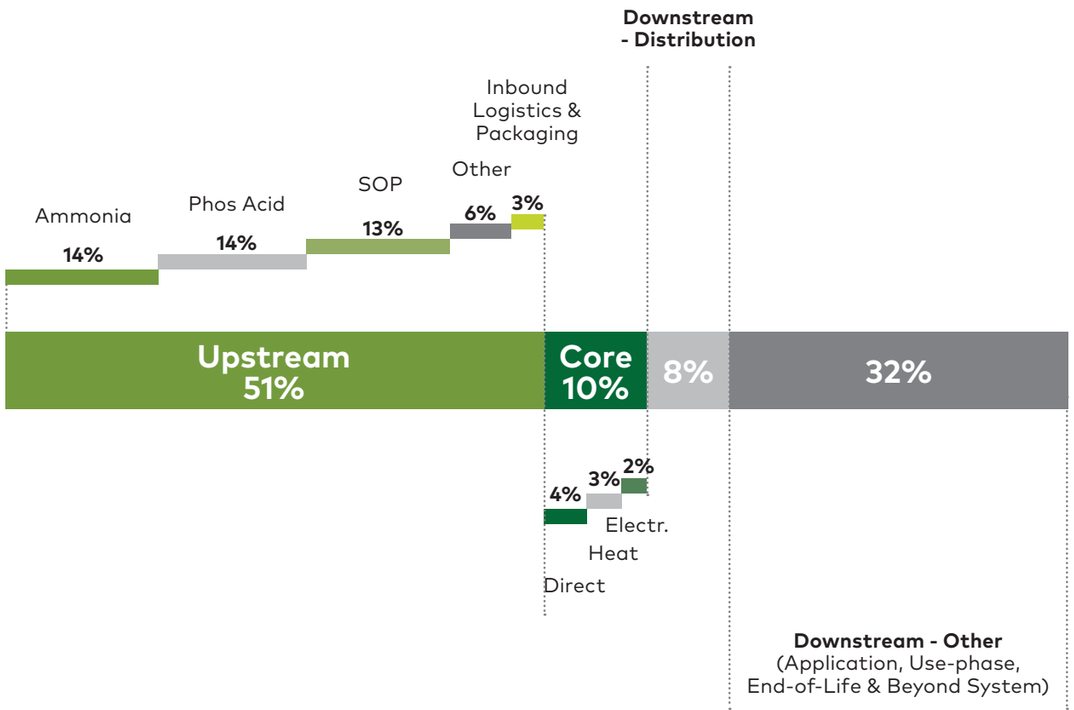
Considering that the type of transport is unknown, the following reference from the Ecoinvent database was used to model waste transport: Transport, freight, lorry, unspecified {RER}| market for transport, freight, lorry, unspecified | Cut-off, U.

In the SimaPro software, the interpretation of the results can be twofold, in addition to the numerical value, there is the possibility of a graphical display.

Predstavljanje rezultata
Presentation of results

Poslovni sistem Elixir Group je blagovremeno i studiozno pokrenuo pripremu i implementaciju Zelene agende i strategije dekarbonizacije Hemijske divizije, koju čine proizvodne članice Elixir Zorka – Mineralna đubriva i Elixir Prahovo – Industrija hemijskih proizvoda. Ova agenda je uključila detaljnu analizu sadašnjeg stanja, plan strateških investicionih projekata, kao i pripremu za monitoring i izveštavanje tokom tranzicionog perioda u primeni nove EU regulative za prekogranično prilagođavanje emisije ugljenika.

The Elixir Group business system promptly and studiously initiated the preparation and implementation of the Green Agenda and the decarbonization strategy of the Chemical Division, which consists of the production members Elixir Zorka - Mineral Fertilizers and Elixir Prahovo - Industry of Chemical Products. This agenda included a detailed analysis of the current situation, a plan of strategic investment projects, as well as preparation for monitoring and reporting during the transition period in the application of the new EU regulation for cross-border adaptation of carbon emissions.



Analizom životnog ciklusa proizvoda, uz pomoć SimaPro softvera i EcoInvent baze emisionih faktora, na primeru NPK 12:12:17 + 2 % MgO + 14 % S + 0,02 % B + 0,01 % Zn (SOP) proizvedenog u NPK pogonu Elixir Zorke, preliminarno je konstatovano da:

- Najveći deo uljeničnog otiska proizvoda (**51%**) dolazi iz „**Upstream operacija**“, u okviru kojih se izdvaja:
  - uticaj ugrađenih emisija u osnovne sirovine poput amonijaka (14%), fosforne kiseline (14%) i kalijum sulfata (13%);
  - dok manji deo ugljeničnog otiska (6%) nastaje zbog upotrebe pomoćnih sirovina;
  - kao i same ulazne logistike i pakovanja sirovina (3%)
- „**Core operacije**“, koje se odnose na proizvodne procese i potrošnju energije unutar fabričkog kompleksa, doprinose sa **10%** ukupnom ugljeničnom otisku, od čega:
  - 4 % direktne emisije pogona
  - 3 % upotreba toplotne energije, odnosno vodene pare dobijene iz prirodnog gasa
  - 2 % upotreba električne energije
- **Distribucija** gotovog proizvoda sa kupcima, kreira **8%** ugljeničnog otiska. Ovo je direktan rezultat udaljenosti kupaca ove NPK formulacije, koja je namenjena globalnoj prodaji i završava na velikom broju udaljenih tržišta.
- Pored distribucije, **ostali delovi „Downstream operacija“**, koji obuhvataju fazu aplikacije, upotrebe, „End-of-Life“ i „Beyond System“ fazu, neophodni su da bi se kompletirao životni ciklus proizvoda. U ovom slučaju, pripisani su generički podaci kao prosečne vrednosti za mineralna đubriva u svetu, koji u zbiru čine **32%** ukupnog ugljeničnog otiska našeg NPK proizvoda.

Kao što se iz priloženog može videti, izradom procene životnog ciklusa proizvoda obuhvaćen je širi opseg analize, čiji će samo jedan deo biti predmet CBAM izveštavanja. CBAM kroz usvojenu regulativu i implementacione akte za sektor mineralnih đubriva, sužava obuhvat ugljeničnog otiska na:

- relevantne prekursore, u smislu ugrađenih emisija u sirovinama iz kojih se proizvodi azotna (N) aktivna materija u mineralnim đubrivima tj. amonijak i druge azotne sirovine,
- ostale direktne emisije, usled potrošnje toplotne energije
- indirektnu emisiju, usled potrošnje električne energije.

By analyzing the life cycle of the product, with the help of SimaPro software and the EcoInvent database of emission factors, on the example of NPK 12:12:17 + 2 % MgO + 14 % S + 0,02 % B + 0,01 % Zn (SOP) produced in the NPK plant of Elixir Zorka, it was preliminarily stated that:

- The largest part of the product footprint (**51%**) comes from „**Upstream operations**“, which include:
  - the impact of incorporated emissions in basic raw materials such as ammonia (14%), phosphoric acid (14%) and potassium sulfate (13%);
  - while a smaller part of the carbon footprint (6%) is due to the use of auxiliary raw materials;
  - as well as the incoming logistics and packaging of raw materials (3%)
- „**Core operations**“, which refer to production processes and energy consumption within the factory complex, contribute **10%** to the total carbon footprint, of which:
  - 4% of direct plant emissions
  - 3% use of thermal energy, i.e. water vapor obtained from natural gas
  - 2% use of electric power
- **Distribution** of the finished product with customers, creates **8%** carbon footprint. This is a direct result of the remoteness of buyers of this NPK formulation, which is intended for global sales and ends up in a large number of distant markets.
- In addition to distribution, **other parts of „Downstream operations“**, which include the application, use, „End-of-Life“ and „Beyond System“ phases, are necessary to complete the product life cycle. In this case, generic data were assigned as average values for mineral fertilizers in the world, which together make up **32%** of the total carbon footprint of our NPK product.

As can be seen from the presented, the preparation of the product life cycle assessment covers a wider scope of analysis, only one part of which will be the subject of CBAM reporting. Through the adopted regulation and implementing acts for the mineral fertilizers sector, CBAM narrows the scope of the carbon footprint to:

- relevant precursors, in terms of incorporated emissions in the raw materials from which the nitrogen (N) active substance in mineral fertilizers is produced, i.e. ammonia and other nitrogenous raw materials,
- other direct emissions, due to thermal energy consumption
- indirect emissions due to electric power consumption.

Akcije koje vode zelenoj tranziciji i dekarbonizaciji

Actions leading to green transition and decarbonization

U skladu sa rezultatima LCA analize, cirkularna ekonomija, alternativni i obnovljivi izvori energije su postali sastavni deo strategije dekarbonizacije Elixir Group do 2030.

In accordance with the results of the LCA analysis, the circular economy, alternative and renewable energy sources have become an integral part of Elixir Group's decarbonization strategy by 2030.

Cirkularna ekonomija u fokusu poslovanja Elixir Group

Circular economy in the focus of Elixir Group's business

Cirkularna ekonomija je obnovljiva industrijska ekonomija koja ima promenjeni koncept proizvodnje i potrošnje prema dizajnu, upotrebi resursa i odnosu prema stvaranju otpada. U konceptu cirkularne ekonomije otpad ne postoji, već samo sirovina koja se opet može ponovo upotrebiti za iste ili druge proizvodne procese. Takođe, obnovljivi izvori energije imaju prioritet, energija se koristi efikasno, podstiču se inovativne tehnologije, zelene javne nabavke, zamena opasnih hemikalija manje opasnim, a promene u navikama potrošača su neminovne.

Circular economy is a renewable industrial economy that has a changed concept of production and consumption according to design, use of resources and relation to waste generation. In the concept of circular economy, waste does not exist, but only raw material that can be reused for the same or other production processes. Also, renewable energy sources have priority, energy is used efficiently, innovative technologies are encouraged, green public procurement is encouraged, hazardous chemicals are replaced by less hazardous ones, and changes in consumer habits are inevitable.

Cirkularni dizajn predstavlja jedan od glavnih preduslova cirkularne ekonomije. Dizajn je cirkularan ukoliko je u procesu kreiranja proizvoda uzeto u obzir kako će se taj proizvod ili njegovi delovi koristiti nakon isteka životnog ciklusa proizvoda. U fabrikama mineralnih đubriva koje su u vlasništvu Elixir Group, kada proizvod izgubi potrebna fizička ili hemijska svojstva, to ne znači da su i materijali od kojih je sastavljen neupotrebljivi. Takav proizvod se vraća u proces proizvodnje gde mu se ili svojstva poboljšaju ili se njegove aktivne materije ugrađuju u nov proizvod. Misija u cirkularnoj ekonomiji jeste da se otpad svede na nulu **(zero-waste)** i to se dešava u fabrikama za proizvodnju mineralnih đubriva.

Nakon upotrebljenog proizvoda, ostaje samo ambalaža sa kojom se postupa u skladu sa dobrom praksom u upravljanju ambalažnim otpadom za šta već 4 godine obe članice kompanije Elixir Group dobijaju i sertifikat o uštedi CO_2 od strane ovlašćenog operatera za upravljanje ambalažnim otpadom, a u skladu sa Zakonom o ambalaži i ambalažnom otpadu.

Circular design is one of the main prerequisites of the circular economy. Design is circular if, in the process of creating a product, it is taken into account how that product or its parts will be used after the end of the product's life cycle. In the mineral fertilizer factories owned by Elixir Group, when the product loses the necessary physical or chemical properties, it does not mean that the materials from which it is composed are also unusable. Such a product is returned to the production process where either its properties are improved or its active substances are incorporated into a new product. The mission in the circular economy is to reduce waste to zero **(zero-waste)** and this happens in factories for the production of mineral fertilizers.

After the product has been used, only the packaging remains, which is handled in accordance with good practice in packaging waste management, for which both Elixir Group companies have received a CO_2 saving certificate for 4 years by an authorized operator for packaging waste management, and in accordance with the Law on packaging and packaging waste.

Nakon upotrebljenog proizvoda, ostaje samo ambalaža sa kojom se postupa u skladu sa dobrom praksom u upravljanju ambalažnim otpadom za šta već 4 godine obe članice kompanije Elixir Group dobijaju i sertifikat o uštedi CO_2 od strane ovlašćenog operatera za upravljanje ambalažnim otpadom, a u skladu sa Zakonom o ambalaži i ambalažnom otpadu.

Proizvodne članice Elixir Group mineralna đubriva proizvode po DRUM DEN tehnologiji koja omogućava homogenost reakcione mase, visok stepen reaktivnosti i iskorišćenja aktivnih supstanci. Pored toga što postoji **potpuna recirkulacija praškastih materij**a u fabrikama mineralnih đubriva postoji i **potpuna recirkulacija tečnosti u procesu proizvodnje**, te otpadnih tehnoloških voda nema.

Valja napomenuti da **pri samom projektovanju fabrike se mora razmišljati i o energetskoj efikasnosti**, te je na primer za fabriku mineralnih đubriva odabrana tehnologija koja koristi cevni reaktor, koji je primer energetske efikasnosti u odnosu na proces sa pre-neutralizatorom koji se ranije koristio. Prednost cevnog reaktora je to što daje koncentrovaniju pulpu nego pre-neutralizator i mnogo su manje potrebe za procesnom vodom. Pošto je reakcija svedena na mali prostor (reakcija se odvija u količini od 2 kg i traje nekoliko sekundi), toplotni bilans procesa je takođe unapređen. Pri tome velika količina vode sama otpari usled toplote reakcije, pa je proizvod koji napušta granulator mnogo suvlji i samim tim je smanjena potreba za energijom za sušenje. Prednost procesa sa cevnim reaktorom u odnosu na onaj sa pre-neutralizatorom je i u tome što ima malu potrošnju električne energije.

Da se stalno razmišlja o energetskoj efikasnosti primer je i **nabavka dodatnog kotla manjeg kapaciteta** za proizvodnju vodene pare, a sa ciljem uštede energenata, prirodnog gasa i električne energije. Naime, iskustveno je primećeno da prilikom proizvodnje đubriva sa visokim sadržajem azota, zbog egzotermnosti reakcije, nije potrebna vodena para da se koristi za proces već samo za dogrevanje pomoćnih hemikalija i grejanje ciklona. U tom slučaju, para visokog pritiska (koju proizvodi postojeći veliki kotao Remmnig) je potrebna samo za periodično ili akcidentno produvavanje cevnog reaktora. Postojeći kotao Remming može da radi na minimum opterećenja od 30% i pri tome proizvodi oko 0,6 t/h pare; pri ovakom radu se proizvodi više vodene pare nego što je potrebno (a samim tim javljaju se i toplotni gubici),

After the product has been used, only the packaging remains, which is handled in accordance with good practice in packaging waste management, for which both Elixir Group companies have received a CO_2 saving certificate for 4 years by an authorized operator for packaging waste management, and in accordance with the Law on packaging and packaging waste.

Production members of Elixir Group produce mineral fertilizers using the DRUM DEN technology, which enables the homogeneity of the reaction mass, a high degree of reactivity and the utilization of active substances. In addition to the **complete recirculation of powdered materials** in mineral fertilizer factories, there is also **complete recirculation of liquids in the production process**, and there is no technological waste water.

It should be noted that **energy efficiency must also be considered when designing the factory**, and for example, for the mineral fertilizer factory, a technology using a tubular reactor was chosen, which is an example of energy efficiency compared to the process with a pre-neutralizer that was used earlier. The advantage of the tubular reactor is that it produces a more concentrated pulp than the pre-neutralizer and there is much less need for process water. Since the reaction is reduced to a small space (the reaction takes place in an amount of 2 kg and lasts a few seconds), the heat balance of the process is also improved. At the same time, a large amount of water evaporates due to the heat of the reaction, so the product that leaves the granulator is much drier, and thus the need for energy for drying is reduced. The advantage of the tubular reactor process compared to the one with the pre-neutralizer is that it has a low consumption of electric power.

An example of constantly thinking about energy efficiency **is the purchase of an additional boiler with a smaller capacity** for the production of steam, with the aim of saving energy, natural gas and electric power. Namely, it has been observed empirically that during the production of fertilizers with high nitrogen content, due to the exothermic nature of the reaction, water vapor is not required to be used for the process, but only for reheating auxiliary chemicals and heating the cyclone. In this case, high pressure steam (produced by the existing large Remmnig boiler) is only required for periodic or accidental blowdown of the tubular reactor. The existing Remming boiler can operate at a minimum load of 30% and at the same time produces about 0.6 t/h of steam; during this operation, more water vapor is produced than is necessary (and therefore heat losses also occur).

Kotao Remming troši 72,06 Nm^3/t prirodnog gasa, dok novi kotao, WIMA, troši 66,67 Nm^3/t proizvedene pare. Dakle, ugradnjom kotla kapaciteta 1,5 t/h i smajenjem proizvodnje vodene pare ostvaruje se **ušteda u potrošnji prirodnog gasa**.

The Remming boiler consumes 72.06 Nm^3/t of natural gas, while the new boiler, WIMA, consumes 66.67 Nm^3/t of produced steam. Therefore, by installing a boiler with a capacity of 1.5 t/h and reducing the production of water vapor, **savings in natural gas consumption are achieved**.

Kada je reč o uštedi prirodnih resursa, projekat koji je zaživeo uz pomoć Ministarstva zaštite životne sredine i UNDP koji u partnerstvu sprovode projekat „Smanjenje ugljeničnog otiska lokalnih zajednica primenom principa cirkularne ekonomije u Republici Srbiji – Cirkularne zajednice“, uz finansijsku podršku Globalnog fonda za životnu sredinu (GEF), jeste **korišćenje istrošenih kiselina i baza u procesu proizvodnje mineralnih đubriva i to kao zamena za deo skruberske tečnosti**. Skruberska tečnost predstavlja mešavinu doziranih koncentrovanih kiselina, rastvora istrošenih kiselina i baza, sveže tehnološke vode i apsorbovanih i neutralisanih čestica iz procesa prečišćavanja vazdušnih tokova koji se odvija u skruberskom sistemu. Unutar skruberske tečnosti se odvijaju reakcije između kiselih i baznih supstanci (neutralizacija).

When it comes to saving natural resources, the project that came to life with the help of the Ministry of Environmental Protection and UNDP, which in partnership implement the project „Reducing the carbon footprint of local communities by applying the principles of circular economy in the Republic of Serbia - Circular Communities“, with the financial support of the Global Environment Facility (GEF), **is the use of spent acids and bases in the process of producing mineral fertilizers as a replacement for part of the scrubbing liquid**. The scrubbing liquid is a mixture of dosed concentrated acids, solutions of spent acids and bases, fresh technological water and absorbed and neutralized particles from the air flow purification process that takes place in the scrubber system. Reactions between acidic and basic substances (neutralization) take place inside the scrubber liquid.

Skruberska tečnost recirkuliše u sistemu, apsorbuje i neutrališe čestice gasova i mikronske prašine koji se na taj način uklanjaju iz vazdušnih tokova, a kasnije potpuno ugrađuju u proizvod. Ona se kontinualno izuzima iz skruberskog sistema i dozira u proces preko reaktorske posude superfosfata, odnosno preko cevnog reaktora ili granulatura, a takođe se kontinualno i u istoj proporciji dopunjava svežom tehnološkom vodom automatskim doziranjem preko završnog skrubera. Na ovaj način **uspostavlja se stabilan bilans tečnosti u tehnološkom procesu i vrši potpuno iskorišćenje supstanci**, kako iz standardnih tečnih sirovina, tako i iz rastvora istrošenih kiselina i baza, kao alternativnih sirovina, **bez generisanja otpadnih voda ili tečnog i čvrstog ostatka (reziduala)**.

Sa druge strane, prateći najbolje svetske prakse, kompanija Elixir Group ušla je u industrijsku simbiozu sa brojnim kompanijama u zemlji i inostranstvu. **Industrijska simbioza, za koju se kaže da oponaša prirodu, predstavlja sistem koji povezuje industrije, gde se nusproizvod jedne industrije koristi kao ulazni resurs drug**e. Na ovaj način deo standardnih sirovina menjamo alternativnim. Ovo ima veoma značajan uticaj pre svega na uštedu resursa, jer bi ove, za nas značajne sirovine, da nismo ušli u industrijsku simbiozu, završile kao opasan otpad industrija gde su nastale. Model kruženja materije, odnosno njene ponovne upotrebe doprinosi povećanju upotrebe sirovina i istovremeno smanjenju korišćenja energije, vode i drugih resursa.

Elixir Prahovo je nastalo na načelima cirkularne ekonomije i industrijske simbioze. Davne, 1960. godine, Industrija hemijskih proizvoda Prahovo (IHP Prahovo) osnovana je kao fabrika superfosfata odnosno kao nastavak tehnološkog lanca metalurškog kompleksa Basen – Bor. Nastavljajući takvu tradiciju, nastao je i aluminijum-fluorid, gde se silikofluorovodonična kiselina, koja nastaje kao nusproizvod fabrike za proizvodnju fosforne kiseline, direktno koristi u fabrici za proizvodnju AlumoFluora (AlF_3). **Ponovna upotreba nusproizvoda stvara novu vrednost i štiti životnu sredinu**. Tehnologija za proizvodnju ovog katalitzatora koristi električnu energiju proizvedenu iz CO_2 neutralnog izvora (hidroelektrana Đerdap), kao i TNG energiju, kao jednu od najčistijih izvora energije (tečni naftni gas).

The scrubber liquid recirculates in the system, absorbs and neutralizes gas particles and micron dust, which are thus removed from the air streams, and later completely incorporated into the product. It is continuously withdrawn from the scrubber system and dosed into the process via the superphosphate reactor vessel, i.e. via the tubular reactor or granulation, and it is also continuously and in the same proportion replenished with fresh technological water by automatic dosing via the final scrubber. In this way, **a stable liquid balance is established in the technological process and substances are fully utilized**, both from standard liquid raw materials and from solutions of spent acids and bases, as alternative raw materials, **without generating waste water or liquid and solid residue**.

On the other hand, following the best world practices, the company Elixir Group has entered into an industrial symbiosis with numerous companies in the country and abroad. **Industrial symbiosis, which is said to imitate nature, is a system linking industries, where the by-product of one industry is used as an input resource of another**. In this way, we replace part of the standard raw materials with alternative ones. This has a very significant impact, first of all, on the saving of resources, because these, for us, important raw materials, if we had not entered into an industrial symbiosis, would have ended up as dangerous waste of the industries where they were created. The model of material circulation, i.e. its reuse, **contributes to an increase in the use of raw materials and, at the same time, a reduction in the use of energy, water and other resources**.

Elixir Prahovo was established on the principles of circular economy and industrial symbiosis. Long ago, in 1960, the Industry of Chemical Products Prahovo (IHP Prahovo) was founded as a superphosphate factory, i.e. as a continuation of the technological chain of the Basin-Bor metallurgical complex. Continuing such a tradition, aluminum fluoride was also created, where silicofluoric acid, which is produced as a by-product of the factory for the production of phosphoric acid, is directly used in the factory for the production of AlumoFluor (AlF_3). **The reuse of by-products adds new value and protects the environment**. The technology for the production of this catalyst uses electric power produced from a CO_2-neutral source (hydroelectric plant Đerdap), as well as LPG energy, as one of the cleanest sources of energy (liquefied petroleum gas).

Proaktivan pristup Elixir Group prema obnovljivim izvorima sirovina

Elixir Group's proactive approach to renewable sources of raw materials

Fosfor je okarakterisan kao kritičan sa aspekta zaliha od strane Evropske Komisije. Ciklus fosfora je jedan od najsporijih biogeohemijskih ciklusa na Zemlji. Njegovo kretanje od stena, preko zemljišta do okeana je veoma sporo (500 miliona godina). Sa druge strane, fosfor je neophodan za život i njegov nedostatak negativno utiče na sav živi svet na Zemlji. Ovaj element je vitalna komponenta svih živih organizama, jer je gradivna supstanca DNK i RNK, igra bitnu ulogu u prenosu energije kroz žive ćelije, a kao gradivna komponenta fosfolipida, doprinosi stvaranju ćelijskih membrana.

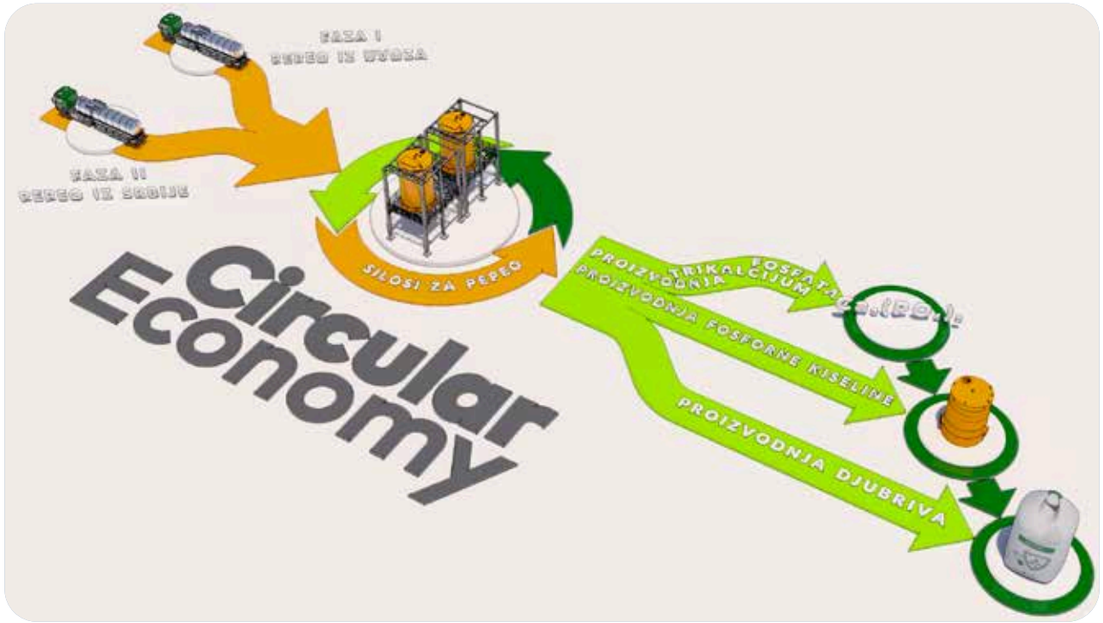
Phosphorus is characterized as critical from a stock perspective by the European Commission. The phosphorus cycle is one of the slowest biogeochemical cycles on Earth. Its movement from rocks, over land to the ocean is very slow (500 million years). On the other hand, p**hosphorus is necessary for life** and its lack negatively affects all living beings on Earth. This element is a vital component of all living organisms, because it is the building substance of DNA and RNA, it plays an important role in the transfer of energy through living cells, and as a building component of phospholipids, it contributes to the creation of cell membranes.

Svoje potrebe za fosforom, svi živi organizmi, obezbeđuju putem hrane, a on u hrani potiče iz biološkog unosa fosfora iz zemljišta. Kako se broj ljudi na planeti sve više povećava, a neke procene su da će globalna populacija porasti na 9,3 milijarde 2050. godine, očekuje se da će se narednih godina potražnja za hranom povećati za preko 60 %. U skladu sa tim, moraće se povećati i poljoprivredna i prehrambena proizvodnja koje su među glavnim uzrocima iscrpljivanja prirodnih resursa. Već danas, **brzina kojom se eksploatišu fosfatna ležišta je daleko veća od proporcionalne brzine kojom se ona formiraju** i u suštini to čini fosfor neobnovljivim resursom.

Godinama unazad istražuju se novi resursi koji mogu biti zamena za fosfatnu stenu u proizvodnji đubriva i drugih supstanci koje sadrže fosfor. Kao alternativa, javila se mogućnost primene pepela kanalizacionog mulja. Proizvodne članice Elixir Group pokrenule su **projekat korišćenja pepela kanalizacionog mulja u proizvodnji mineralnih đubriva i fosforne kiseline** koji predstavlja proaktivan način razmišljanja kompanije koja već sada ispituje mogućnost zamene sirovog fosfata ovom alternativnom sirovinom.

All living organisms provide their phosphorus needs through food, and it comes from the biological uptake of phosphorus from the soil. As the number of people on the planet continues to increase, and some estimates are that the global population will grow to 9.3 billion in 2050, it is expected that the demand for food will increase by over 60% in the coming years. Accordingly, agricultural and food production, which are among the main causes of depletion of natural resources, will have to increase. Already today, **the rate at which phosphate deposits are exploited is far greater than the proportional rate at which they are formed**, essentially making phosphorus a non-renewable resource

For years, new resources have been researched that can be a substitute for phosphate rock in the production of fertilizers and other substances containing phosphorus. As an alternative, the possibility of using sewage sludge ash appeared. Elixir Group's production members launched a **project to use sewage sludge ash in the production of mineral fertilizers and phosphoric acid**, which represents a proactive way of thinking of the company, which is already examining the possibility of replacing raw phosphate with this alternative raw material.



Laboratorijskim ispitivanjima je ustanovljeno da **pepeo kanalizacionog mulja može da zameni od 10-30 % sirovog fosfata** u proizvodnji fosforne kiseline i mineralnih đubriva.

Pored ovog značajnog projekta, koji je u fazi akceleratocije u okviru „EU za Zelenu agendu", paralelno se radi i **projekat Rekonstrukcije, sanacije i adaptacije postrojenja za prečišćavanje otpadnih voda na lokaciji Elixir Prahovo** kojim je predviđena, prema principima cirkularne ekonomije, upotreba **mulja iz drugog stepena prečišćavanja otpadne tehnološke vode** iz procesa proizvodnje fosforne kiseline **u svrhu ponovnog iskorišćenja reziduala fosfora**. Takođe, predviđeno je i delimično vraćanje i ponovno iskorišćenje prečišćene vode u procesu proizvodnje fosforne kiseline.

Laboratory tests have shown that **sewage sludge ash can replace 10-30% of raw phosphate** in the production of phosphoric acid and mineral fertilizers.

In addition to this important project, which is in the acceleration phase within the framework of the „EU for the Green Agenda", the **project Reconstruction, rehabilitation and adaptation of the wastewater treatment plant at the Elixir Prahovo** location is being worked on in parallel, which foresees, according to the principles of the circular economy, the use of sludge from of the second stage of purification of technological waste water from the phosphoric acid production process **for the purpose of reusing phosphorus residues**. It is also planned to partially return and reuse purified water in the process of phosphoric acid production

Waste to energy projekti
Waste to energy projects

Energija koja se koristi u Elixir Prahovu još uvek nije u skladu sa principima cirkularne ekonomije, jer se ne dobija iz obnovljivih izvora, međutim energija potrebna za proizvodnju Elixir Zorke dobija se iz prirodnog gasa kao tranzitnog energenta. U Prahovu se trenutno koriste ugalj i mazut kao energenti za dobijanje toplotne energije potrebne za uparavanje fosforne kiseline, a kako je LCA analiza pokazala - neophodno je da se to promeni, jer fosilno poreklo ovih energenata dominantno utiče na visok ugljenični otisak fosforne kiseline i replikuje se na ugljenični otisak mineralnih đubriva u kojima ona učestvuje kao jedna od ključnih sirovina.

Po ugledu na razvijene države sveta, **Elixir Group implementira Waste to Energy koncept iskorišćenja toplotne energije dobijene iz alternativnih energenata sa ciljem dekarbonizacije toplotne energije koja se koristi u proizvodnim procesima hemijske industrije**. U planu je izgradnja energane za energetsko iskorišćenje otpada i proizvodnju vodene pare potrebne u proizvodnim procesima fosforne kiseline u Prahovu.

Ulogu termičkog tretmana nereciklabilnog opasnog i neopasnog otpada možemo posmatrati trojako:

- Otpad koji se ne može reciklirati pretvara se u energiju (ali delimično i u sirovine) na ekološki bezbedan način i time se sprečava njegovo deponovanje,
- Obezbeđuje energetsku sigurnost zajednice, odnosno smanjuje njenu energetsku zavisnost od, uglavnom uvoznih, klasičnih (fosilnih) goriva,
- Smanjuje negativne uticaje na klimatske promene, zamenom fosilnih goriva koja bi se koristila za proizvodnju energije u konvencionalnim elektranama ili toplanama.

The energy used in Elixir Prahovo is still not in accordance with the principles of the circular economy, because it is not obtained from renewable sources, however, the energy required for the production of Elixir Zorka is obtained from natural gas as a transit energy source. In Prahovo, coal and fuel oil are currently used as energy sources to obtain the thermal energy needed for the vaporization of phosphoric acid, and as the LCA analysis showed - it is necessary to change this, because the fossil origin of these energy sources has a dominant effect on the high carbon footprint of phosphoric acid and is replicated on the carbon footprint of mineral fertilizers in which it participates as one of the key raw materials.

In imitation of the developed countries of the world, **Elixir Group implements the Waste to Energy concept of using thermal energy obtained from alternative energy sources with the aim of decarbonizing the thermal energy used in the production processes of the chemical industry**. The plan is to build a power plant for the energy utilization of waste and the production of steam needed in the production processes of phosphoric acid in Prahovo.

The role of thermal treatment of non-recyclable hazardous and non-hazardous waste can be observed in three ways:

- Non-recyclable waste is converted into energy (but also partly into raw materials) in an environmentally safe way, thus preventing its landfilling.
- It ensures the community's energy security, i.e. reduces its energy dependence on, mainly imported, classic (fossil) fuels,
- It reduces negative impacts on climate change, by replacing fossil fuels that would be used for energy production in conventional power plants or long-distance-heating plants.

Ovaj projekat predstavlja dugoočekivano rešenje za jedan od najvećih izazova sa kojima se Republika Srbija suočava u oblasti upravljanja otpadom i doprinosi:

- **smanjenju količine otpada koji se odlaže na deponiju i doprinosi transformaciji privrede sa linearnog modela poslovanja na cirkularan, uz efikasno korišćenje resursa;**
- **unapređenju ekološke i socijalne sredine uz sprečavanje negativnih uticaja na životnu sredinu, kao što je narušavanje okolnog predela zbog odlaganja otpada na deponiju i trajnom uklanjanju nepoželjnih i štetnih materije koje bi odlaganjem kontaminirale zemljište, površinske vode i vazduh.**

Realizacijom projekta, **kompanija Eixir Group ali i Srbija, biće lideri u primeni najboljih praksi u oblasti životne sredine i socijalne zaštite u regionu**; ovim će se napraviti značajan iskorak u pravcu približavanja Republike Srbije evropskim planovima za održivi razvoj i dekarbonizaciju privrede, što je istovremeno i ekološki i resursni imperativ savremene industrije.

Postrojenje za termički tretman nereciklabilnog opasnog i neopasnog otpada se projektuje prema tehnologiji „TBU Stubenvoll" GMBH, sa sedištem u Austriji, kompanije koja je ostvarila više dokazanih referenci sa postrojenjima sličnog tipa na prostoru Evrope.

Ovaj projekat je u fazi akceleracije u okviru projekta „Inovativna i pravedna tranzicija kao alat za obezbeđivnje sistemske energetske sigurnosti i smanjenje energetskog siromaštva" koji podržava Vlada Japana, a sprovodi UNDP.

Pored ovoga, **Elixir Group razmatra koncept za razvoj zelenog vodonika**, kroz primer svoje fabrike u Prahovu, a reč je o proizvodu koji se može plasirati na lokalna i okolna tržišta, pa sve do Evrope, koja je veliki uvoznik energenata. Zeleni vodonik ima ključnu ulogu za postizanje jednog od ciljeva održivog razvoja - neutralisanje CO_2 do 2050. godine. Uticaj na zaštitu životne sredine je drastično umanjenje štetnih emisija, a time i veliki doprinos unapređenju zaštite okruženja. **Održiva proizvodnja vodonika je vizija kako kompanije Elixir Group tako i Evrope i celog sveta.**

This project represents a long-awaited solution to one of the biggest challenges facing the Republic of Serbia in the field of waste management and contributes to:

- **reducing the amount of waste disposed of in the landfill and contributing to the transformation of the economy from a linear business model to a circular one, with efficient use of resources;**
- **improving the ecological and social environment while preventing negative impacts on the environment, such as the destruction of the surrounding landscape due to the disposal of waste at the landfill and the permanent removal of undesirable and harmful substances that would contaminate the soil, surface water and air.**

By implementing the project, **the company Elixir Group, as well as Serbia, will be the leaders in the application of the best practices in the field of environment and social protection in the region**; this will make a significant step towards bringing the Republic of Serbia closer to European plans for sustainable development and decarbonization of the economy, which is at the same time an environmental and resource imperative of modern industry.

The plant for thermal treatment of non-recyclable hazardous and non-hazardous waste is designed according to the technology of „TBU Stubenvoll" GMBH, based in Austria, a company that has achieved several proven references with plants of a similar type in Europe.

This project is in the acceleration phase within the project „Innovative and just transition as a tool for ensuring systemic energy security and reducing energy poverty" supported by the Government of Japan and implemented by UNDP.

In addition to this, **Elixir Group is considering a concept for the development of green hydrogen**, through the example of its factory in Prahovo, and it is a product that can be placed on local and surrounding markets, all the way to Europe, which is a large importer of energy products. Green hydrogen plays a key role in achieving one of the goals of sustainable development - the neutralization of CO_2 by 2050. The impact on environmental protection is a drastic reduction of harmful emissions, and thus a great contribution to the improvement of environmental protection. **Sustainable hydrogen production is the vision of Elixir Group as well as of Europe and the whole world**.

Obnovljivi izvori energije

Renewable sources of energy

Investicijama u obnovljive izvore energije i maksimiziranjem cirkularnosti u proizvodnim procesima cilj je da do 2030. godine postignemo potpunu ugljeničnu neutralnost. Pored waste to energy projekta, planira se i izgradnja solarnih i vetro elektrana, kao i hemijska reciklaža plastike.

By investing in renewable energy sources and maximizing circularity in production processes, the goal is to achieve complete carbon neutrality by 2030. In addition to the waste to energy project, the construction of solar and wind power plants is planned, as well as the chemical recycling of plastics.

PREVENCIJA
Najpoželjniji otpad je upravo onaj koji smo sprečili da nastane. Na tome treba da radimo svakodnevno i sveobuhvatno.

Status Quo Elixir Group je:
- NULA nereciklabilnog otpada i otpadnih voda iz procesa proizvodnje mineralnih đubriva;
- Reciklaža sopstvenog ambalažnog otpada 100%;
- Reciklaža sopstvenih nestandardnih proizvoda 100%.

SMANJENJE
Tamo gde ne možemo da sprečimo nastanak otpada, možemo da utičemo na smanjenje količine i učestalosti. Do rešenja se dolazi doslednom primenom načela cirkularne ekonomije.

PONOVNA UPOTREBA
Jednokratna upotreba i odbacivanje materijala je suprotna načelima cirkularne proizvodnje. Ponovnom upotrebom doprinosimo i smanjenju količine otpada i smanjenju upotrebe novih prirodnih resursa.

PONOVNO ISKORIŠĆENJE
Ako ne možemo da sprečimo, smanjimo ili ponovo upotrebimo određeni materijal, umesto toga možemo da ga upotrebimo za druge namene. Otpad je postao validan resurs, sa rasponom mogućnosti iskorišćenja kao sirovine ili kao energenta. Investicije u ove tehnologije su značajne, ali su benefiti višestruki i još značajniji.

Ponovno iskorišćenje materijala je moguće ukoliko su ispunjeni sledeći postulati:
- Primenjuje se adekvatna tehnologija;
- Ne postoji negativan uticaj na životnu sredinu;
- Ne narušava se kvalitet proizvoda.

REFUSE
The most desirable waste is precisely the one which we have refused to generate. We should work on it daily and comprehensively.

Elixir Group's Status Quo is:
- ZERO non-recyclable waste and wastewater from the mineral fertilizer production process;
- 100% recycling of own packaging waste;
- 100% recycling of own non-standard products

REDUCE
Where we cannot refuse the generation of waste, we can influence the reduction of the amount and frequency of generation. The solution is reached through the consistent application of circular economy principles.

REUSE
The one-time use and discarding of materials is contrary to the principles of circular production. By reusing, we contribute to reducing the amount of waste and reducing the use of new natural resources.

REPURPOSE
If we cannot refuse, reduce or reuse a particular material, we can repurpose it instead. Waste has become a valid resource, with a range of possibilities for use as a raw material or as an energy source. Investments in these technologies are significant, but the benefits are multiple and even more significant.

Repurpose of materials is possible if the following postulates are met:
- Adequate technology is applied;
- There is no negative impact on the environment;
- Product quality is not impaired.

RECIKLAŽA

Na kraju, ali ne i najmanje važno, imamo recikliranje. Reciklaža je ekološki najprihvatljiviji metod postupanja sa otpadom. Ovde možemo da budemo i kreativni i inovativni. Mogućnosti su velike, od reciklaže kancelarijskog materijala do složenih procesa hemijske reciklaže i dobijanja novih proizvoda koje vraćamo u nove proizvodne cikluse cirkularne ekonomije.

Kada je u pitanju otpad, potrebno je na svakom koraku razmisliti. I onda ponovo razmisliti. Ponovnim preispitivanjem smanjiće se sigurno količina generisanog otpada.

Ovde je značajno spomenuti i **hemijski lizing** kao relativno novi model poslovanja, koji je nastao uporedo sa razvojem ideje čistije proizvodnje. Model je orijentisan na pružanje usluge korisniku i pomera fokus sa povećanja obima prodaje hemikalija ka prodaji funkcije same hemikalije. Rezultat primene modela je efikasnije korišćenje hemikalija uz smanjenje rizika povezanog sa njihovim korišćenjem, kao i zaštita zdravlja ljudi. Sam model promoviše ideju sprečavanja zagađenja, a ne otklanjanje posledica kad one već nastanu. Ovo je poslovni model koji koristi i industriji i životnoj sredini.

RECYCLE

Last but not least, there is recycling. Recycling is the most environmentally friendly method of handling waste. Here we can be both creative and innovative. The possibilities are great, from office material recycling to complex chemical recycling processes and obtaining new products that we return to the new production cycles of the circular economy.

When it comes to waste, you need to think at every step. And then re-think. Re-thinking will certainly reduce the amount of generated waste.

Here, it is important to mention **chemical lease** as a relatively new business model, which arose simultaneously with the development of the idea of cleaner production. The model is oriented towards providing a service to the user and shifts the focus from increasing the volume of chemical sales to selling the function of the chemical itself. The result of applying the model is more efficient use of chemicals while reducing the risk associated with their use, as well as protecting people's health. The model itself promotes the idea of preventing pollution, rather than eliminating the consequences once they occur. This is a business model beneficial to both industry and the environment.

Uključivanje zaposlenih u akcije dekarbonizacije

Involvement of employees in decarbonization actions

Potrebno je pokretati najpre male projekte koje vode promeni navika zaposlenih, pa onda polako ići dalje ka sve većim. Kada zaposleni veruju u projekte koje pokrećete, uspeh je zagarantovan. Takođe, treba podsticati zaposlene da pruže podršku u projektima koji unapređuju kvalitet života u lokolnoj zajednici.

Jedan od manjih projekata na koji smo ponosni jeste **implementicija sistema za odgovorno upravljanje štampanjem i skeniranjem**. Elixir Group je implementirao sistem koji omogućava svim zaposlenima da bezbedno štampaju, skeniraju i distribuiraju dokumenta. Tokom realizacije projekta **smanjen je broj štampača**, tako da se sada koristi samo centralizovani štampači. Štampa se aktivira prilikom korišćenja korisničke kartice i time **korisnik bira željenu štampu**, bez bojazni da je drugi korisnik greškom uzeo njegove odštampane dokumente. Takođe, prilikom puštene pogrešne štampe, kada se utroši i po više desetina papira, ista se može videti i obrisati pre štampe i samim tim se uštedi i papir i toner za pogrešno puštenu štampu.

U samom početku implementacije projekta najpre su zaposleni prošli edukaciju o značaju štampanja samo najneophodnijih dokumenate i benefita koje donosi ovaj projekat.

It is necessary to start small projects that lead to changes in employees' habits, and then slowly move on to bigger ones. When employees believe in the projects you start, success is guaranteed. Employees should also be encouraged to provide support in projects that improve the quality of life in the local community.

One of the smaller projects we are proud of is the **implementation of a system for responsible printing and scanning management**. Elixir Group has implemented a system that allows all employees to securely print, scan and distribute documents. During the implementation of the project, **the number of printers was reduced**, so now only centralized printers are used. Printing is activated when using the user card, and thus **the user chooses the desired printing**, without fear that another user has mistakenly taken his printed documents. Also, when a wrong print is released, when several dozens of sheets of paper are used, it can be seen and deleted before printing, thus saving both paper and toner for the wrong print.

At the very beginning of the implementation of the project, the employees were first educated about the importance of printing only the most necessary documents and the benefits that this project brings.

Rezultat ovog projekta je i te kako vidljiv. **Na godišnjem nivou je procenjeno da se štedi oko 1,2 t papira što je ušteda od 29 stabla (plus drugi resursi potrebni za proizvodnju, poput vode i električne energije).**

Za kraj, delimo sa vama nekoliko saveta koje možete praktikovati kako biste smanjili ugljenični otisak vaše kancelarije:

- **Smanjite potrošnju energije**. Isključujte svetla i električne uređaje kada nisu u upotrebi. Koristite energetski efikasne sijalice i aparate.
- Ako je moguće **pređite na korišćenje obnovljive energije** za snabdevanje električnom energijom u vašoj kancelariji.
- **Smanjenjite potrošnju papira**. Koristite elektronsku poštu i digitalne dokumente kad god je to moguće. Ako morate štampati, onda koristite dvostrano štampanje kako biste smanjili količinu potrošenog papira.
- **Razvrstavajte svoj otpad i postarajte se da bude recikliran kada god je to moguće.**
- **Smanjenjite upotrebu plastike**. Izbegavajte upotrebu jednokratne plastike, kao što su plastične čaše, slamke i posude za hranu. Koristite višekratne posude i boce za vodu.
- **Organizujte sastanke putem video konferencija kako biste smanjili putovanja**. Koriste bicikl, javni prevoz ili delite prevoz kada dolazite na posao.
- **Opremite kancelariju energetski efikasnim uređajima, poput računara, kako biste smanjili potrošnju električne energije**. Laptopovi su 80% energetski efikasniji u odnosu na desktop računare. Takođe, podesite računar da uđe u režim uštede energije nakon kratkog vremena mirovanja, tako da nećete brinuti o tome koliko energije računar troši tokom sastanka. Pre nego što odete na odmor ili koristite slobodan dan, isključite svoje gadžete i uključite računar u stanje spavanja
- **Razmislite o nabavci održivih i ekološki prihvatljivih proizvoda za kancelariju**, kao što su reciklirani materijali, olovke od reciklirane plastike ili novina, itd.
- **Redovno pratite potrošnju energije i vode, količinu generisanog otpada i druge ekološke parametre kako biste videli napredak i identifikovali oblasti za poboljšanje.**

Uključivanjem ovih praksi u svakodnevno funkcionisanje kancelarije, može se doprineti globalnim naporima u borbi protiv klimatskih promena i istovremeno smanjiti troškove poslovanja na dugoročnoj osnovi.

The result of this project is also visible. **On an annual basis, it is estimated that around 1.2 t of paper is saved, which is a saving of 29 trees (plus other resources needed for production, such as water and electric power).**

Finally, we share with you some tips that you can practice to reduce the carbon footprint of your office:

- **Reduce energy consumption**. Turn off lights and electrical appliances when not in use. Use energy-efficient light bulbs and appliances.
- If possible, **switch to using renewable energy** for the electricity supply in your office.
- **Reduce paper consumption.** Use email and digital documents whenever possible. If you must print, then use double-sided printing to reduce the amount of paper used.
- **Sort your waste and make sure it is recycled whenever possible.**
- **Reduce the use of plastic.** Avoid using single-use plastics, such as plastic cups, straws and food containers. Use reusable containers and water bottles.
- **Organize meetings via video conferencing to reduce travel**. Use a bicycle, public transport or carpool to get to work.
- **Equip the office with energy-efficient devices, such as computers, to reduce electric power consumption**. Laptops are 80% more energy efficient than desktop computers. Also, set your computer to enter power-saving mode after a short period of idle time, so you won't have to worry about how much power your computer is using during a meeting. Before you go on vacation or use a day off, turn off your gadgets and put your computer to sleep.
- **Consider sourcing sustainable and environmentally friendly office supplies**, such as recycled materials, recycled plastic pens or newspapers, etc.
- **Regularly monitor energy and water consumption, amount of waste generated and other environmental parameters to see progress and identify areas for improvement.**

By incorporating these practices into the daily functioning of the office, one can contribute to the global efforts to combat climate change and at the same time reduce the cost of doing business on a long-term basis.

LITERATURA

Association of Issuing Bodies (2021). European Residual Mixes, Results of the calculation of Residual Mixes for the calendar year 2020., Available at: https://www.aib-net.org/sites/default/files/assets/facts/residual-mix/2020/AIB_2020_Residual_Mix_Results.pdf

Brentrup, F., Hoxha, A., & Christensen, B. (2016, October). Carbon footprint analysis of mineral fertilizer production in Europe and other world regions. In Conference Paper, The 10th International Conference on Life Cycle Assessment of Food (LCA Food 2016).

Cresko, J., Rightor, E., Carpenter, A., Peretti, K., Elliott, N., Nimbalkar, S., ... & Liddell, H. (2022). DOE Industrial Decarbonization Roadmap (No. DOE/EE-2635). USDOE Office of Energy Efficiency and Renewable Energy (EERE).

Čarapina, H. S., Jovović, A., & Stepanov, J. (2010). Ocena životnog ciklusa LCA (Life Cycle Assessment) kao instrument u strateškom planiranju upravljanja otpadom. Beograd: Univerzitet Educons.

EeBGuide. C-05 Transport of wastes to landfill, incineration and recycling facilities – screening and simplified. Available at: https://www.eebguide.eu/eebblog/?p=1636

Ecochain: Life Cycle Assessment (LCA) – Complete Beginner's Guide. Available at: https://ecochain.com/blog/life-cycle-assessment-lca-guide/

European Commisdion. Carbon Border Adjustment Mechanism. Available at: https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en

European Commission, Joint Research Centre, Prussi, M., Yugo, M., De Prada, L., et al., JEC well-to-tank report V5: JEC well-to-wheels analysis: well-to-wheels analysis of future automotive fuels and powertrains in the European context, Publications Office, 2020, https://data.europa.eu/doi/10.2760/959137.

Eurostat. (2018) Treatment of waste by waste category, hazardousness and waste management operations. Available at: https://ec.europa.eu/eurostat/databrowser/view/ENV_WASTRT__custom_2453034/default/table?lang=en .

IPCC 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories 11.3 (updated).

Gaidajis, G., & Kakanis, I. (2020). Life cycle assessment of nitrate and compound fertilizers production - A case study. Sustainability, 13(1), 148.

Guinee, J. B., Heijungs, R., Huppes, G., Zamagni, A., Masoni, P., Buonamici, R., ... & Rydberg, T. (2011). Life cycle assessment: past, present, and future.

Mitrović, S., Radosavljević, I., & Veselinov, M. (2017). Cirkularna ekonomija kao šansa za razvoj Srbije. Organization for Security and Co-operation in Europe.

REFERENCES

Association of Issuing Bodies (2021). European Residual Mixes, Results of the calculation of Residual Mixes for the calendar year 2020., Available at: https://www.aib-net.org/sites/default/files/assets/facts/residual-mix/2020/AIB_2020_Residual_Mix_Results.pdf

Brentrup, F., Hoxha, A., & Christensen, B. (2016, October). Carbon footprint analysis of mineral fertilizer production in Europe and other world regions. In Conference Paper, The 10th International Conference on Life Cycle Assessment of Food (LCA Food 2016).

Cresko, J., Rightor, E., Carpenter, A., Peretti, K., Elliott, N., Nimbalkar, S., ... & Liddell, H. (2022). DOE Industrial Decarbonization Roadmap (No. DOE/EE-2635). USDOE Office of Energy Efficiency and Renewable Energy (EERE).

Čarapina, H. S., Jovović, A., & Stepanov, J. (2010). Ocena životnog ciklusa LCA (Life Cycle Assessment) kao instrument u strateškom planiranju upravljanja otpadom. Beograd: Univerzitet Educons.

EeBGuide. C-05 Transport of wastes to landfill, incineration and recycling facilities – screening and simplified. Available at: https://www.eebguide.eu/eebblog/?p=1636

Ecochain: Life Cycle Assessment (LCA) – Complete Beginner's Guide. Available at: https://ecochain.com/blog/life-cycle-assessment-lca-guide/

European Commisdion. Carbon Border Adjustment Mechanism. Available at: https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en

European Commission, Joint Research Centre, Prussi, M., Yugo, M., De Prada, L., et al., JEC well-to-tank report V5: JEC well-to-wheels analysis: well-to-wheels analysis of future automotive fuels and powertrains in the European context, Publications Office, 2020, https://data.europa.eu/doi/10.2760/959137.

Eurostat. (2018) Treatment of waste by waste category, hazardousness and waste management operations. Available at: https://ec.europa.eu/eurostat/databrowser/view/ENV_WASTRT__custom_2453034/default/table?lang=en .

IPCC 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories 11.3 (updated).

Gaidajis, G., & Kakanis, I. (2020). Life cycle assessment of nitrate and compound fertilizers production - A case study. Sustainability, 13(1), 148.

Guinee, J. B., Heijungs, R., Huppes, G., Zamagni, A., Masoni, P., Buonamici, R., ... & Rydberg, T. (2011). Life cycle assessment: past, present, and future.

Mitrović, S., Radosavljević, I., & Veselinov, M. (2017). Cirkularna ekonomija kao šansa za razvoj Srbije. Organization for Security and Co-operation in Europe.

Perović, S., Vučinić, A. (2020). Mapa puta za cirkularnu ekonomiju u Srbiji. Ministarstvo zaštite životne sredine, Sektor za strateško planiranje i projekte.

Reimann, D. O. (2012). CEWEP energy report III. Scientific & Technical Advisor to CEWEP, Bamberg Dezember.

Rockström, J., Gaffney, O., Rogelj, J., Meinshausen, M., Nakicenovic, N., & Schellnhuber, H. J. (2017). A roadmap for rapid decarbonization. Science, 355(6331), 1269-1271.

Salkunić, A., Belobaba, N., Salkunić, B., Stanojević, L., & Bogdanović, S. (2022). Priprema kompanije Elixir Group za uvođenje prekograničnog mehanizma za prilagođavanje ugljenika na granicama EU (CBAM). Zbornik Međunarodnog kongresa o procesnoj industriji–Procesing, 35(1), 155-163.

Salkunić, A., Vuković, J., & Smiljanić, S. (2022). Review of Technologies for the Recovery of Phosphorus from Waste Streams. Chemical and Biochemical Engineering Quarterly, 36(2), 91-116.

Skowrońska, M., & Filipek, T. (2014). Life cycle assessment of fertilizers: a review. International Agrophysics, 28(1).

SRPS ISO 14040 Upravljanje zaštitom životne sredine — Ocenjivanje životnog ciklusa — Principi i okvir

SRPS ISO 14044 Upravljanje zaštitom životne sredine — Ocenjivanje životnog ciklusa — Zahtevi i uputstva za primenu

SRPS EN ISO 14067 Gasovi staklene bašte — Ugljenični otpad proizvoda — Zahtevi i smernice za kvantifikaciju

Vidovic, D., Marmier, A., Zore, L. & Moya, J. (2023). Greenhouse gas emission intensities of the steel, fertilisers, aluminium and cement industries in the EU and its main trading partners. Luxembourg: Publications Office of the European Union.

Zampori, L., & Pant, R. (2019). Suggestions for updating the Product Environmental Footprint (PEF) method. Publications Office of the European Union: Luxembourg.

Walters, R. N., Hackett, S. M., & Lyon, R. E. (2000). Heats of combustion of high temperature polymers. Fire and materials, 24(5), 245-252.

World Steel Association. (2017). Life cycle inventory methodology report for steel products. World Steel Association, Brussels.

https://ambassadors-env.com/

https://climate.nasa.gov/

https://climatepromise.undp.org/

https://public.wmo.int/en

https://www.fertilizerseurope.com/

https://www.klimatskepromene.rs/

Perović, S., Vučinić, A. (2020). Mapa puta za cirkularnu ekonomiju u Srbiji. Ministarstvo zaštite životne sredine, Sektor za strateško planiranje i projekte.

Reimann, D. O. (2012). CEWEP energy report III. Scientific & Technical Advisor to CEWEP, Bamberg Dezember.

Rockström, J., Gaffney, O., Rogelj, J., Meinshausen, M., Nakicenovic, N., & Schellnhuber, H. J. (2017). A roadmap for rapid decarbonization. Science, 355(6331), 1269-1271.

Salkunić, A., Belobaba, N., Salkunić, B., Stanojević, L., & Bogdanović, S. (2022). Priprema kompanije Elixir Group za uvođenje prekograničnog mehanizma za prilagođavanje ugljenika na granicama EU (CBAM). Zbornik Međunarodnog kongresa o procesnoj industriji–Procesing, 35(1), 155-163.

Salkunić, A., Vuković, J., & Smiljanić, S. (2022). Review of Technologies for the Recovery of Phosphorus from Waste Streams. Chemical and Biochemical Engineering Quarterly, 36(2), 91-116.

Skowrońska, M., & Filipek, T. (2014). Life cycle assessment of fertilizers: a review. International Agrophysics, 28(1).

SRPS ISO 14040 Upravljanje zaštitom životne sredine — Ocenjivanje životnog ciklusa — Principi i okvir

SRPS ISO 14044 Upravljanje zaštitom životne sredine — Ocenjivanje životnog ciklusa — Zahtevi i uputstva za primenu

SRPS EN ISO 14067 Gasovi staklene bašte — Ugljenični otpad proizvoda — Zahtevi i smernice za kvantifikaciju

Vidovic, D., Marmier, A., Zore, L. & Moya, J. (2023). Greenhouse gas emission intensities of the steel, fertilisers, aluminium and cement industries in the EU and its main trading partners. Luxembourg: Publications Office of the European Union.

Zampori, L., & Pant, R. (2019). Suggestions for updating the Product Environmental Footprint (PEF) method. Publications Office of the European Union: Luxembourg.

Walters, R. N., Hackett, S. M., & Lyon, R. E. (2000). Heats of combustion of high temperature polymers. Fire and materials, 24(5), 245-252.

World Steel Association. (2017). Life cycle inventory methodology report for steel products. World Steel Association, Brussels.

https://ambassadors-env.com/

https://climate.nasa.gov/

https://climatepromise.undp.org/

https://public.wmo.int/en

https://www.fertilizerseurope.com/

https://www.klimatskepromene.rs/

ElixirGroup
Za bolji svet

Headquarter
Bulevar Oslobođenja 79
21000 Novi Sad, Srbija
+381 21 215 54 24
+381 21 215 54 25
office@elixirgroup.rs

Šabac
Hajduk Veljkova1
15000 Šabac, Srbija
+381 15 352 718
+381 15 352 740