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Poseben pomen kovin v krožnem gospodarstvu

The Special Importance of Metals in a Circular Economy

1 Uvod

Ko je bilo leta 2015 na Generalni skupščini ZN sprejetih 17 ciljev trajnostnega razvoja [1], so bili še vedno oblikovani kot vizija doseganja boljšega sveta z več blaginje in manjšo porabo virov, zdaj pa vstopamo v čas, ko se deli te vizije spreminjajo v zakone [2]. Akcijski načrt EU za krožno gospodarstvo [3] na primer postavlja pomen trajnosti in razvoja trajnostnih procesov v središče evropske politike. Kaj je trajnostno in kaj ne, je treba opisati, razvrstiti in posebej spodbujati, npr. tudi skozi upravljanje finančnih tokov. Čeprav sta poudarjanje trajnosti in spodbujanje ustreznih načinov pomembna za njeno doseganje, obstajajo določeni pomisleki, ali je to, kar je relativno enostavno opisati, pravno opredeliti in nato odločiti v upravah političnih institucij in podjetij v finančni industriji, vedno tehnično izvedljivo. Navsezadnje ima tudi krožno gospodarstvo znanstvene in tehnične omejitve, ki jih je treba sprejeti z vidika gospodarske učinkovitosti.

Vendar pa je treba trajnost obravnavati tudi v okviru strukturnih sprememb v nacionalnih gospodarstvih. Razvoj na področju kovin [4] kaže, da so v tradicionalnih industrijskih družbah v Evropi in na Japonskem potekle strukturne spremembe iz industrijskih v storitvene družbe, ki so v svetovni jeklarski in livarski industriji začasno več kot očitno privedle do tega, da se poraba jekla in litih izdelkov na prebivalca v obdobju med letoma 1970 in 1995 ni več povečala, v nekaterih primerih pa se je ob naraščanju svetovnega

1 Introduction

When the 17 Sustainable Development Goals [1] were adopted at the UN General Assembly in 2015 they were still formulated as a vision of how to achieve a better world with more prosperity and less resource consumption, we are now entering a time in which parts of this vision are beginning to become law [2]. For example, the EU's Circular Economy Action Plan [3] brings the importance of sustainability and the development of sustainable processes into the focus of European policy. What is sustainable and what is not is to be described, classified, and specifically promoted, e.g. also through the management of financial flows. As important as the emphasis on sustainability and the promotion of appropriate ways to achieve it are, there are certain concerns if what is relatively easily described, legally defined, and then decided upon in the administrations of political institutions and companies in the financial industry is always technically feasible. After all, even a circular economy has scientific and technical limits that have to be accepted in terms of economic efficiency.

However, sustainability must also be considered in the context of structural changes in national economies. Developments in the field of metals [4] show that in the traditional industrial societies in Europe and Japan, structural changes from industrial to service societies have taken place, which have temporarily led very clearly in the global steel and foundry

prebivalstva v absolutnem smislu celo zmanjšala [5]. Na izbranih področjih je torej že prišlo do dematerializacije svetovne gospodarske rasti. Z industrializacijo na Kitajskem se je ta razvoj končal, zlasti na začetku tega stoletja, in ponovno je prišlo do eksponentne rasti z izjemno porabo surovin in rastjo cen. Vendar se bo ta razvoj v naslednjih dveh desetletjih zelo verjetno končal, ko se bo tudi na Kitajskem zgodila strukturna sprememba iz industrijske v storitveno družbo [5].

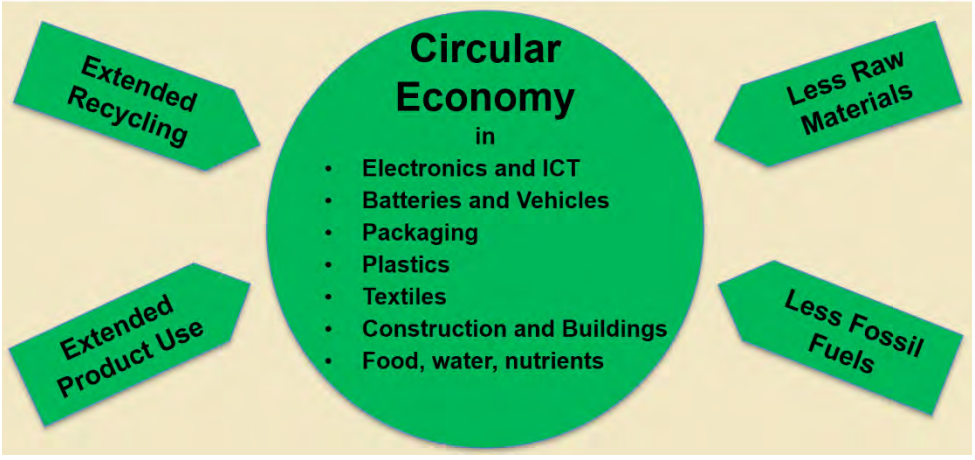
2 Katere so značilnosti krožnega gospodarstva?

V prvi vrsti je cilj ustvariti svetovno blaginjo z gospodarsko rastjo ob čim manjši porabi energetskih in neenergetskih surovin. Slika 1 prikazuje najpomembnejše vrednostne verige, opredeljene v akcijskem načrtu EU za krožno gospodarstvo [3]. V prihodnosti bo treba v teh vrednostnih verigah porabiti manj energije in surovin, kar je mogoče doseči z oblikovanjem trajnostnih izdelkov (Slika 2), ki jih je mogoče uporabljati dlje

industry to the fact that the per capita consumption of steel and cast products in the period between 1970 and 1995 has no longer increased and in some cases, even the absolute consumption has decreased [5] with a growing world population. Here, then, the dematerialization of global economic growth has already taken place in selected areas. With the industrialization in China, this development has ended, especially at the beginning of this century, and exponential growth with extreme raw material consumption and price increases has taken place again. However, this development will very likely end in the next two decades, namely when the structural change from an industrial to a service society will also take place in China [5].

2 What are the Characteristics of a Circular Economy?

Above all, the goal is to generate global prosperity through economic growth while consuming as few energetic and non-energetic raw materials as possible. Figure



Slika 1. Ključne vrednostne verige izdelkov po akcijskem načrtu EU za krožno gospodarstvo [6].

Figure 1. Key product value chains following the EU's Circular Economy Action Plan [6].

časa in jih je mogoče tudi popraviti, kot je bil običaj pred desetletji.

V naslednjih nekaj desetletjih je zato mogoče pričakovati, da bo obseg novih izdelkov rasel manj ali morda celo stagniral, namesto tega pa se bodo proizvajali izdelki z višjo vrednostjo.

Hkrati pa se bodo razvijala nova poslovna področja, na katerih se bodo izdelki z ustreznimi zagotovili za kakovost obnavljali in znova dajali na trg kot obnovljeni izdelki. Pregled na spletu pokaže, da je ta poslovni model že uveljavljen na področju mobilnih telefonov. Rabljeni avtomobili so že desetletja sestavni del avtomobilske industrije, trenutne razmere pa kažejo, da se zaradi dolgih čakalnih dob na nove avtomobile povečuje posel z rabljenimi avtomobili, ki jih je treba prav tako tudi ustrezno popraviti. Takšen razvoj bo povzročil delno nadomestitev izgubljenih delovnih mest na področju nove proizvodnje s podobnimi delovnimi mesti, vendar na področju vzdrževanja in popravil. S tega vidika bodo proizvajalci vse bolj zainteresirani za nadaljnji dostop do svojih visokokakovostnih izdelkov, zato se bodo

1 shows the most important value chains defined in the EU's Circular Economy Action Plan [3]. In the future, less energy and raw materials will have to be consumed in these value chains, which can be achieved by designing sustainable products (Fig. 2) that can be used for longer and can also be repaired, as it was the case decades ago.

In the next few decades, it can therefore be expected that the volume of new products will tend to grow less strongly or possibly even stagnate, but that higher-value products will be produced instead.

At the same time, however, new areas of business will be developed in which products with appropriate quality assurance guarantees will be reconditioned and put back on the market as refurbished products. A look at the internet shows that this business model is already established in the cell phone business. Used cars have been an integral part of the automotive business for decades and the current situation shows that with long waiting times for new cars, the business with used cars is growing, which then also have to be repaired accordingly. Increasing developments of

Slika 2. Temelji za uresničevanje krožnega gospodarstva [6].

Figure 2. Fundamentals to realize a Circular Economy [6].

v prihodnosti verjetno povečali tudi modeli najema in zakupa, kot je že mogoče zaznati v avtomobilski industriji. To bo veljalo tudi za strojne obrate, kjer bodo sodobne tehnike digitalizacije proizvajalcem omogočile spremljanje in stalno vzdrževanje obratov ter celo njihovo izboljšanje z novo razvitimi komponentami z obratovanjem brez prekinitev. To pomeni, da se bo dodana vrednost še naprej ustvarjala, vendar ob bistveno manjši porabi virov.

Pri tem pa je treba zelo jasno poudariti, da je treba v krožnem gospodarstvu nenehno razvijati nove inovativne izdelke z izboljšano funkcionalnostjo in boljšim razmerjem med ceno in zmogljivostjo, saj ti pomembno in odločilno prispevajo k izboljšanju trajnosti. V svetu kovin obstajajo odlični primeri. Sodobna jekla in liti izdelki so res dober primer, saj so zaradi boljših mehanskih lastnosti lažji kot v preteklosti, zato se v proizvodnji porabi manj surovin. Pomembno vprašanje je, ali se bo tak razvoj, ki je rezultat desetletij raziskav in razvoja, zgodil tudi v prihodnosti, če po taksonomiji EU tovrstnega dela ni mogoče neposredno uvrstiti med okoljske cilje iz 9. člena, ki so opredeljeni v Uredbi (EU) 2020/852 Evropskega parlamenta in Sveta iz junija 2020 [2]:

a) blažitev podnebnih sprememb;
b) prilagajanje podnebnim spremembam;
c) trajnostna raba ter varstvo vodnih in morskih virov;
d) prehod na krožno gospodarstvo;
e) preprečevanje in nadzorovanje onesnaževanja;
f) varstvo in ohranjanje biotske raznovrstnosti in ekosistemov.

Za prihodnost je ključnega pomena, da se trajnost in popravljivost ne spodbujata na račun inovacij in novih optimiziranih izdelkov z boljšimi lastnostmi.

this kind will lead to the partial replacement of lost jobs in the area of new production by similar jobs but in the area of maintenance and repair. From this point of view, producers will be increasingly interested in continuing to have access to their high-quality products, so rental and leasing models will presumably also increase in the future, as can already be observed in the automotive industry. This will also be the case for mechanical engineering plants, where modern digitalization techniques will enable the producer to monitor and continuously maintain the plants and even improve them through newly developed components in continuous operation. This means that value will continue to be added, albeit with significantly lower consumption of resources.

In this context, however, it must be very clearly pointed out that in a circular economy, new innovative products with improved functionalities and better price/performance ratios must continuously be developed, as they make an important decisive contribution to improving sustainability. Very good examples we are having in the world of metals. So are modern steels and cast products really good examples, because they are lighter than in the past, due to better mechanical properties and therefore consume fewer raw materials in production. The important question is, if such developments, which are the result of decades of research and development will happen in the future, if following the EU's taxonomy this kind of work cannot be classified directly into the environmental objectives of Article 9 which are defined in the Regulation (EU) 2020/852 of the European Parliament and the Council of June 2020 [2]:

a) climate change mitigation;
b) climate change adaptation;
c) the sustainable use and protection of

3 Znanstveno-tehnične osnove postopkov recikliranja

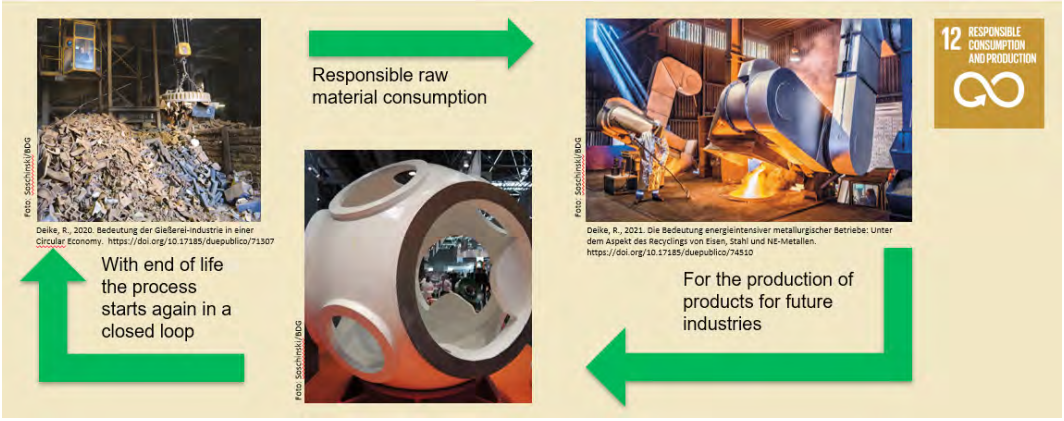
V prihodnosti bodo izdelki verjetno dosegli konec življenjske dobe veliko pozneje, vendar bodo kljub temu dosegli konec svoje življenjske dobe v življenjskem ciklu izdelka, nato pa jih bo treba reciklirati, da se bodo lahko vrnili v cikel materialov. Vendar je to mogoče samo v podjetjih iz kovinske, jeklarske in livarske industrije [7,8], ki imajo na tem področju že zdaj pomemben položaj, saj imajo te industrije v nekaterih primerih že izrazito zaprte surovinske cikle. Livarska industrija že desetletja počne to, kar EU zahteva za prihodnost: v livarski industriji se iz nečesa starega, tj. iz odpadkov, proizvede nekaj novega z boljšimi lastnostmi (Slika 3). To je mogoče ponavljati skoraj v neskončnost, čeprav je treba pri tem upoštevati tudi izgube materiala zaradi žlindre in praha v filtrih, ki so sicer glede na celotno maso majhne, vendar obstajajo in jih je treba upoštevati, zato surovinski cikli

water and marine resources;
d) the transition to a circular economy;
e) pollution prevention and control;
f) the protection and restoration of biodiversity and ecosystems.

It is crucial for the future that durability and repairability are not promoted at the expense of innovations and new optimized products with better properties.

3 Scientific-Technical Basics of Recycling Processes

Nevertheless, in the future, products will presumably reach the end of life (EoL) state much later, but they will reach the end of their life in the product life cycle and then they will have to be recycled so that they can be returned to the materials cycle. However, this can only be done with companies in the metal, steel, and foundry industries [7,8], which already have a prominent position from this point of view, as these industries already have very closed raw material



Slika 3. Železarska industrija že desetletja proizvaja v izrazito zaprtih surovinskih krogih, zato že danes počne to, kar EU želi za prihodnost [6].

Figure 3. The iron foundry industry is producing in highly closed raw materials loops for decades and therefore doing today what the EU wants for the future [6].

ne morejo biti nikoli popolnoma zaprti, tudi če si del družbe to želi in zahteva.

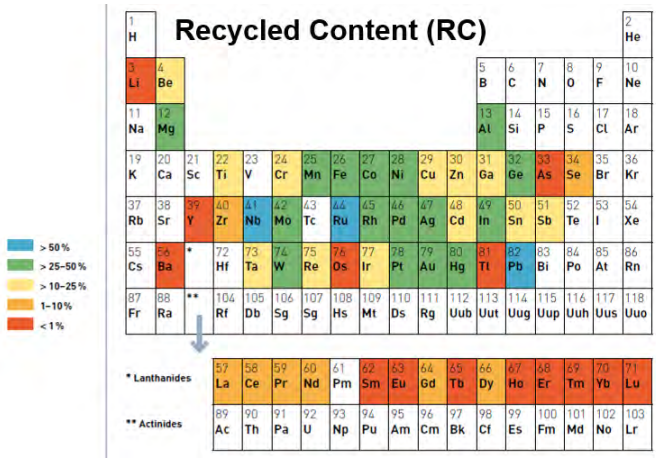
Če upoštevamo stopnje ponovne uporabe odpadnih kovin za proizvodnjo (vsebnost recikliranih kovin) novih kovin (Slika 4), vidimo, da so stopnje vsebnosti recikliranih kovin pri elementih, označenih z modro in zeleno barvo, ki vključujejo tudi železo in druge industrijske kovine, bistveno višje kot pri drugih elementih, kot so zlasti redke zemlje.

Zato je v političnih izjavah pogosto slišati, da se mora to v prihodnosti spremeniti in da je treba tudi tu doseči vrednote, kot so tiste za industrijske kovine. Ta zahteva, ki se zdi na prvi pogled zelo logična, pa se tu sreča z znanstveno in tehnično oviro – entropijo! Kaj to pomeni? Elementi z nizko vsebnostjo recikliranih materialov se pogosto uporabljajo v funkcionalnih materialih, ki se nato uporabljajo za proizvodnjo mobilnih telefonov, zaslonov, elektronskih komponent itd. Pri izdelavi takšnih izdelkov se elementi in spojine v fazi uporabe izdelka porazdelijo zelo razpršeno.

cycles in some cases. The foundry industry has been doing for decades what the EU demands the future, in the foundry industry something new with better properties is produced from something old, namely, scrap (Fig. 3) and this can be repeated almost infinitely, although it must also be taken into account here that there are material losses via slags and filter dust which, although small in relation to the total mass, nevertheless exist and must be mentioned, so that there can never be 100 % closed raw material cycles, even if parts of society wish and demand it.

If the rates of reuse of scrap for the production (recycled content) of new metals are considered (Fig. 4), it is noticeable that there are significantly higher rates of recycled content for the elements marked in blue and green, which include also iron together with other industrial metals, than for other elements, such as rare earth in particular.

Therefore, it is very often heard in political statements that this must change



Slika 4. Vsebnost različnih elementov v reciklaži [9].

Figure 4. The Recycled Content of different elements [9].

V enem samem mobilnem telefonu so te kovine prisotne le v majhnih koncentracijah, kar pomeni, da je entropija že tu razmeroma visoka. Če pa upoštevamo milijarde mobilnih telefonov, ki so razpršeni po vsem svetu, se entropija zaradi razpršene porazdelitve še mnogokrat poveča.

Kaj je entropija in zakaj je pogosto izjemna ovira za učinkovito recikliranje, kot npr. v primeru redkih zemelj? Na to vprašanje lahko morda celovito odgovorimo s pomočjo Slike 5. Na sliki je deset evrov v obliki bankovca in pa v obliki desetih posameznih kovancev. Vprašanje pa je, kakšna je med njimi sploh razlika?

Slika 5. Entropija je pogosto ena največjih ovir pri recikliranju.

Figure 5. Entropy is often one of the biggest barriers to recycling.

Če je plačilo izvedeno z desetimi kovanci, je treba izvesti več dela! Razumljivo je, da ta izjava naleti na nerazumevanje, saj je dodatno delo v tej porazdelitvi tako majhno, da sploh ne igra nobene vloge. Če bi deset kovancev z vso močjo vrgli skozi okno, še vedno obstajajo, vendar so izjemno razpršeni – entropija, ki je merilo za neurejenost, se je s tem izjemno povečala, tako da kovancev ne bi več začeli zbirati, saj bi bilo potrebno delo bistveno preveliko.

in the future and that values such as those for industrial metals must also be achieved here. This demand, which seems very logical in a first approach, meets here however with a scientific and technical barrier, the entropy! What is to be understood by this? Elements with low recycled content are often used in functional materials, which in turn are used for the production of cell phones, screens, electronic components, etc. By manufacturing such products, the elements and compounds are distributed highly dissipative during the product use phase. In a single cell phone, these metals are only contained in a small concentration, i.e., here the entropy is already relatively high and if we now consider the billions of cell phones that are distributed around the world, then this dissipative distribution increases the entropy again many times over.

What is it about entropy and why is it often an extreme obstacle to effective recycling, as is the case with rare earth? This question can perhaps be answered in a comprehensible way with the help of Figure 5. Here, ten euros can be seen in the form of a banknote and the form of ten individual coins, and the question is, what is the difference now?

If payment is made with the ten coins, more work must be expended! Understandably, this statement now meets with incomprehension because the additional work is so small in this present distribution that it doesn't play any role at all. If the ten coins are thrown now mentally with all strength out of the window, then they are still present, but in an extremely dissipative distribution, i.e., the entropy which is a measure for the disorder has increased thereby extremely, so that one would not begin to collect the coins again since the work expenditure would be much too large. In dissipative distribution, the

V primeru razpršenosti kovanci izgubijo svojo vrednost, čeprav so še vedno prisotni. V takšnih razmerah gospodarno recikliranje pogosto ni več mogoče; tehnično gledano sicer verjetno je, vendar ob veliko večjem vloženem delu in energiji, zaradi česar bi celotna zadeva postala neekonomična.

Pomen te težave je mogoče dobro ponazoriti z naslednjim primerom iz resničnega sveta recikliranja. Pri sežiganju komunalnih odpadkov v Evropi nastaja kot odpadni produkt pri sežiganju pepel, imenovan pepel iz sežigalnic. V Nemčiji se na leto sežge približno 20 milijonov ton odpadkov ter proizvede 6 milijonov ton pepela. Od tega približno 1,5 milijona ton predstavlja drobna frakcija z delci < 3 mm, ki po konservativnem mnenju [10] vsebuje 0,3–0,4 % Cu (približno 4.500–6-000 t/leto), ta količina kovin pa je enaka kot v bakrovi rudi, ki se danes koplje po svetu. S tega vidika bi lahko pepel iz sežigalnic ne glede na nihanje cen kovin predstavljal dragocen material. Poleg tega lahko na podlagi podatkov iz sežigalnice odpadkov v Švici [11] domnevamo, da je zlato, ki je večinoma povezano s frakcijo, bogato z bakrom, v drobni frakciji (približno 25 % celotne žlindre MV) prisotno v količini 1–2 ppm. Tako vsebnost zlata v fini frakciji žlindre MV ustreza tipični vsebnosti rude v geogenih rudnikih. Tako drobna frakcija pepela, ki se v Nemčiji pretežno reciklira za gradbene namene na odlagališčih, na letni ravni teoretično vsebuje, ob upoštevanju cen kovin, približno 72–144 milijonov EUR [10] bakra, srebra in zlata, ki jih v cikel materialov trenutno ni mogoče vrniti zaradi razpršene porazdelitve, tj. zaradi visoke entropije. Zato je pomembno razviti postopke za recikliranje teh dragocenih sestavin pepela.

S tega vidika ima sežigalnica odpadkov povsem drugačen pomen, in sicer, da s postopkom sežiganja v prvi fazi zgosti

coins lose their value even though they are still present. Under such conditions, an economic recycling is then very often no longer possible, technically probably yes, but evenly with a much higher work and energy expenditure, which makes then the whole thing uneconomical.

The importance of the problem can be explained very well with the following example from the real world of recycling. If municipal waste is incinerated in Europe, the waste incineration ash, called bottom ash is produced as a waste product from the incineration process. In Germany, approx. 20 million tons of waste are incinerated per year and 6 million tons of bottom ash are produced per year. Of this, approx. 1.5 million t is accounted for by the fine fraction < 3 mm, which, on a conservative view [10], contains 0.3–0.4 % Cu (approx. 4,500-6,000 t/a), as much as is contained in a copper ore mined in the world today. From this point of view, bottom ash can be considered a valuable material regardless of metal price fluctuations. Furthermore, based on data from a waste incineration plant in Switzerland [11], it can be assumed that gold, predominantly associated with the copper-rich fraction, is present in the order of 1–2 ppm in the fine fraction (about 25 % of the total MV slag). Thus, the gold contents in the fine fraction of the MV slag correspond to the typical ore contents of geogenic mines. Thus, in total, the fine fraction of bottom ash, which is predominantly recycled in Germany for construction measures on landfills, theoretically contains, depending on the metal prices, approx. 72–144 million € per year [10] of copper, silver, and gold, which currently cannot be returned to the material cycle due to the dissipative distribution, i.e. due to the high entropy. It is therefore important to develop processes to recycle

elemente, ki so v odpadkih izredno razpršeni. V drugi fazi, tj. pri predelavi pepela, se že danes pridobivajo dragoceni materiali, postopke pa bi lahko v prihodnosti še dodatno optimizirali s predelavo drobne žlindre, kot je navedeno zgoraj [12]. Vendar je treba opozoriti, da tisto, kar je smiselno s tehničnega vidika in je tudi gospodarno, glede na trenutno stanje razprav o taksonomiji EU še ne velja za trajnostno in tako predstavlja tipičen primer, da je mogoče postopek popolnoma različno oceniti z vidika tehnologije ter z vidika evropske uprave. Zdaj je edino vprašanje, o katerem odloča družba, katera merila za ocenjevanje bodo v prihodnosti priznana kot pravilna.

4 Gospodarska predvidevanja na področju globalnega sveta kovin

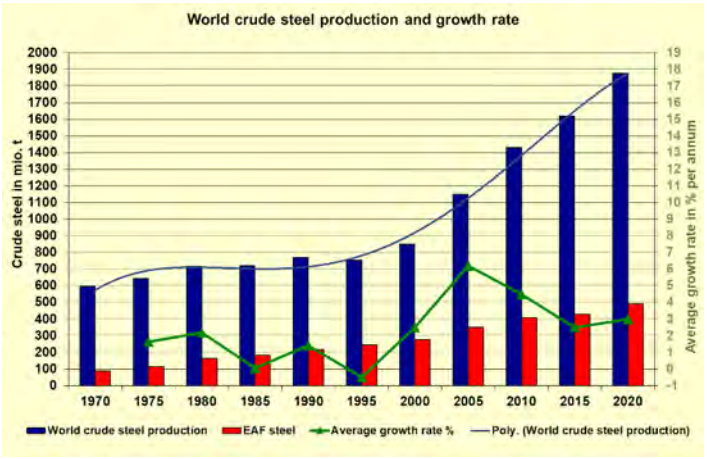
Analize gospodarskega razvoja tradicionalnih industrializiranih držav v Evropi in na Japonskem od začetka sedemdesetih let prejšnjega stoletja kažejo, da je strukturna sprememba iz industrijske v storitveno družbo v teh gospodarstvih povzročila nižje stopnje rasti porabe nekaterih surovin [4, 5] oz., v določenih okoliščinah, porabo nekaterih surovin v absolutno manjših količinah. Na primer, kot smo že omenili zgoraj, so bili učinki nasičenosti v svetovni proizvodnji jekla očitni od začetka sedemdesetih let prejšnjega stoletja, tako da v obdobju od leta 1970 do leta 1995 svetovna proizvodnja jekla skoraj ni rasla (Slika 6). V obdobju med 1990 in 1995 se je svetovna proizvodnja surovega jekla v absolutnem smislu celo zmanjšala, čeprav sta svetovno gospodarstvo in svetovno prebivalstvo v tem obdobju še naprej rasla, kar pomeni, da se je svetovna gospodarska rast na tem področju odvijala brez zvečane porabe jekla.

these valuable components of the bottom ash.

From this point of view, a waste incineration plant has a completely different meaning, namely that through the incineration process, in the first stage, the concentration of the elements distributed extremely dissipative in the waste takes place. In the second stage, in the processing of the bottom ash, the recovery of valuable materials then already takes place today, which can be further optimized in the future by the processing of the fine slag, as mentioned above [12]. However, it should be noted here that what makes sense from a technical point of view and is also economical, is not yet recognized as sustainable according to the current state of the discussion of the EU taxonomy and thus represents a typical example that a process can be evaluated completely differently from the point of view of technology and that of a European administration. Now the only question, taken into the decision by society is, which evaluation criteria will be recognized as correct in the future?

4 Economic Outlook into the Global Metal World

Analyses of the economic developments of the traditional industrialized nations in Europe and Japan since the beginning of the 1970s show that the structural change from an industrial to a service society in the economies concerned has resulted in growth rates for certain raw material consumptions [4,5] becoming lower or, under certain circumstances, in certain raw materials being consumed in lower quantities in absolute terms. For example, as mentioned above, saturation effects have been evident in global steel production since the early 1970s, with the effect that



Slika 6. Svetovna proizvodnja surovega jekla od 1970 do 2020 v petletnih povprečnih vrednostih [6].

Figure 6. Global crude steel production from 1970 to 2020 as five years average values [6].

Podobne logistične funkcije rasti, ki niso tako izrazite kot v primeru svetovne proizvodnje surovega jekla, je mogoče opaziti tudi pri svetovni proizvodnji bakra, niklja in cinka v rudnikih v obdobju od 1970 do približno 1995 [5]. Pri proizvodnji aluminija pa je tak učinek le malo izrazit.

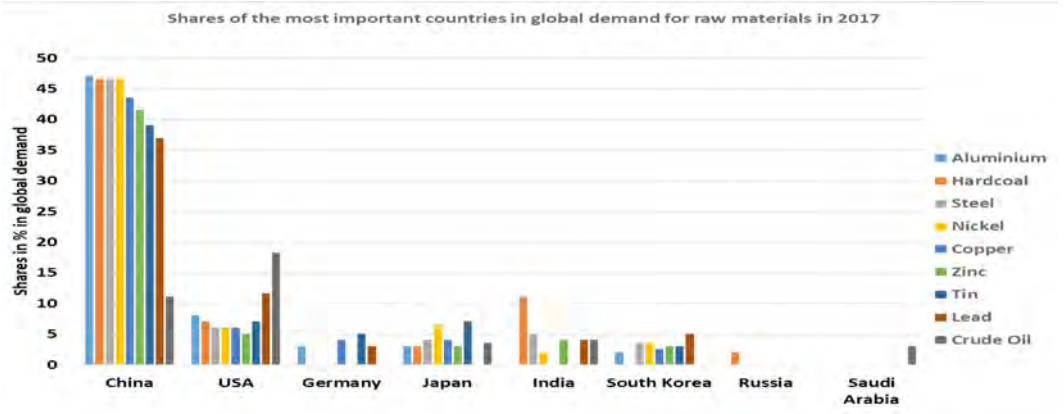
Po letu 1995 je mogoče znova opaziti znatno stopnjo rasti proizvodnje jekla in kovin ter s tem tudi porabe zadevnih surovin, ki jo je povzročil industrijski razvoj na Kitajskem. Zaradi tega razvoja je za trenutne razmere na področju svetovne porabe surovin značilno, da je Kitajska postala prevladujoča država. Na podlagi strukture, prikazane na Sliki 7, bo razvoj na svetovnih trgih surovin v prihodnosti kratkoročno do srednjeročno odvisen od načina gospodarskega razvoja na Kitajskem.

Na Kitajskem je terciarni sektor (Slika 8) leta 2012 prvič močneje prispeval k BDP kot sekundarni sektor. Na tej podlagi je mogoče domnevati, da se bo Kitajska v prihodnjih letih razvila v storitveno družbo [5].

there has been almost no growth in global steel production (Figure 6) in the period from 1970 to 1995. In the period from 1990 to 1995, global crude steel production even declined in absolute terms, although the global economy and the world population continued to grow during this period, i.e. global economic growth took place here without more steel being consumed.

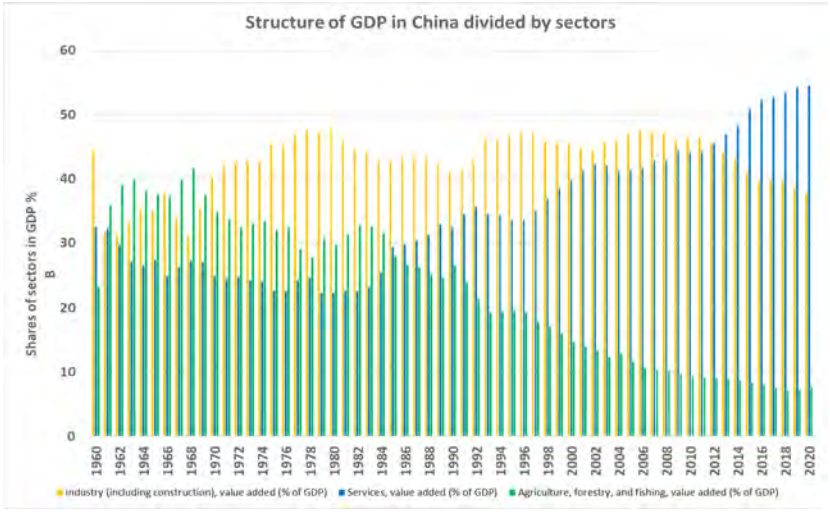
Similar logistic growth functions, but not as pronounced as in the case of world crude steel production, can also be seen in global mine production of copper, nickel, and zinc in the period from 1970 to about 1995 [5]. In the case of aluminum production, however, such an effect is only rudimentarily pronounced.

After 1995, significant growth rates in the production of steel and metals and, accordingly, in the consumption of the corresponding raw materials, caused by the industrial development in China, can be seen again. As a result of this development, the current situation about global consumption of raw materials is characterized by the fact that China has become the dominant



Slika 7. Deleži najpomembnejših držav v svetovnem povpraševanju po surovinah v letu 2017 [5].

Figure 7. Shares of most important countries in global demand for raw materials in 2017 [5].



Slika 8. Struktura BDP na Kitajskem po sektorjih [6].

Figure 8. Structure of GDP in China divided by sectors [6].

Zaradi tega razvoja je mogoče pričakovati podobne učinke na porabo surovin kot v tradicionalnih industrijsko razvitih državah od začetka sedemdesetih let prejšnjega stoletja, kar pomeni, da je mogoče kratkoročno do srednjeročno pričakovati zmerno povečanje porabe

nation. Based on the structure shown in Figure 7, future developments in the global raw material markets will be determined in the short to medium term by how economic development takes place in China.

In China, the tertiary sector (Fig. 8) contributed more to GDP than the

surovin v svetu, ki bo na koncu dolgoročno odvisno od gospodarskega razvoja v Indiji in Afriki. Zaradi povsem različnih političnih struktur v teh državah še vedno ni mogoče sklepati, kako hitro se bodo ta gospodarstva razvijala.

5 Zaključek

Ko je bilo leta 2015 na Generalni skupščini ZN sprejetih 17 ciljev trajnostnega razvoja, so bili še vedno oblikovani kot vizija doseganja boljšega sveta z več blaginje in manjšo porabo virov, zdaj pa vstopamo v čas, ko se deli te vizije spreminjajo v zakone. Ker sta poudarjanje trajnosti in spodbujanje ustreznih načinov za njeno doseganje pomembna, obstajajo določeni pomisleki, ali je to, kar je relativno enostavno opisati, pravno opredeliti in nato odločiti v upravah političnih institucij in podjetij v finančni industriji, vedno tehnično izvedljivo. Navsezadnje ima tudi krožno gospodarstvo znanstvene in tehnične omejitve, ki jih je treba sprejeti z vidika gospodarske učinkovitosti. Razvoj na področju kovin kaže, da so se v tradicionalnih industrijskih družbah v Evropi in na Japonskem zgodile strukturne spremembe iz industrijskih v storitvene družbe, pri čemer je razvidno, da je na izbranih področjih v preteklosti prišlo do dematerializacije globalne gospodarske rasti.

V prvi vrsti je cilj trajnostne prihodnosti ustvariti svetovno blaginjo z gospodarsko rastjo ob čim manjši porabi energetskih in neenergetskih surovin. Razvijala se bodo nova poslovna področja, na katerih se bodo izdelki z ustreznimi zagotovili za kakovost obnavljali in znova dajali na trg kot obnovljeni izdelki. Razvoj na svetovnih trgih surovin v prihodnosti bo kratkoročno do srednjeročno odvisen od načina gospodarskega razvoja na Kitajskem.

secondary sector for the first time in 2012. It can therefore be assumed that China will develop into a service society [5] in the coming years.

As a result of this development, effects can be expected in terms of raw material consumption similar to those that have taken place in the traditional industrialized nations since the beginning of the 1970s, which would mean that moderate increases in raw material consumption in the world can be expected in the short to medium term, which will then be determined in the longer term by the economic developments in India and Africa. Due to the completely different political structures in these countries, it remains to be seen at what speeds these economies will develop.

5 Conclusion

When the 17 Sustainable Development Goals were adopted at the UN General Assembly in 2015 they were still formulated as a vision of how to achieve a better world with more prosperity and less resource consumption, we are now entering a time in which parts of this vision are beginning to become law. As important as the emphasis on sustainability and the promotion of appropriate ways to achieve it are, there are certain concerns if what is relatively easily described, legally defined, and then decided upon in the administrations of political institutions and companies in the financial industry is always technically feasible. After all, even a circular economy has scientific and technical limits that have to be accepted in terms of economic efficiency. Developments in the field of metals show that in the traditional industrial societies in Europe and Japan, structural changes from industrial to service societies have taken place and it can be seen that

Predvidevamo lahko, da se bo Kitajska v prihodnjih letih razvila v storitveno družbo. Zaradi tega razvoja je mogoče pričakovati podobne učinke na porabo surovin kot v tradicionalnih industrijskih državah od začetka sedemdesetih let prejšnjega stoletja, kar bi pomenilo, da je mogoče kratkoročno do srednjeročno pričakovati zmerno povečanje porabe surovin v svetu.

dematerialization of global economic growth has happened in selected areas in the past.

Above all, the goal for a sustainable future is to generate global prosperity through economic growth while consuming as few energetic and non-energetic raw materials as possible. New areas of business will be developed in which products with appropriate quality assurance guarantees will be reconditioned and put back on the market as refurbished products. Future developments in the global raw material markets will be determined in the short to medium term by how economic development takes place in China. It can be assumed that China will develop into a service society in the coming years. As a result of this development, effects can be expected in terms of raw material consumption similar to those that have taken place in the traditional industrialized nations since the beginning of the 1970s, which would mean moderate increases in raw material consumption in the world can be expected in the short to medium term.

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