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ANALIZA STROŠKOV IN KORISTI LOČENEGA ZBIRANJA KOMUNALNIH ODPADKOV
COST-BENEFIT ANALYSIS OF SEPARATED MUNICIPAL WASTE COLLECTION

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V zadnji četrtini prejšnjega stoletja je postal problem ravnanja z vsemi vrstami odpadkov tako pereč, da je prisilil posamezne, predvsem razvitejše države v oblikovanje ustreznih politik na državni in lokalni ravni. Prioritetni cilji teh politik pa so praviloma: zmanjšanje odpadkov na izvoru, ločeno zbiranje, reciklaža in vnovična uporaba odpadkov ter njihovo varno in zanesljivo odstranjevanje. V prispevku je od naštetih ukrepov podrobneje obravnavano ločeno zbiranje in predelava komunalnih odpadkov iz gospodinjstev, pri čemer so nas pri obravnavi zanimali predvsem ekonomski vidiki. S tem v zvezi je v prispevku opredeljen kriterij za določitev ekonomske upravičenosti ločenega zbiranja komunalnih odpadkov, ki smo ga nato formalno zapisali v obliki modela, empirično pa smo ga preizkusili na oskrbnem območju občin Vrhnika in Borovnica. Rezultati raziskave kažejo, da so stroški ravnanja z ločeno zbranimi frakcijami v centru za ravnanje z odpadki znašali v povprečju le 0,05 EUR/kg, s stroški zbiranja in odvoza vred pa 0,08 EUR/kg. Pri mešanemu načinu zbiranja in odvoza komunalnih odpadkov bi znašali skupni stroški ravnanja 0,15 EUR/kg, kar pomeni za 0,08 EUR/kg oziroma 2,02-krat več. Ločeno zbiranje pomeni v konkretnem primeru torej 0,08 EUR prihranka na vsak kg odloženih odpadkov v zabojnike. Model je mogoče z uvedbo dodatnih spremenljivk razširiti z lokalnega tudi na regionalni nivo.
Ključne besede: *komunalni odpadki, ločeno zbiranje, ekonomski vidiki*

In the last quarter of the previous century the treatment of all kinds of waste became an outstanding problem, which compelled individual, mostly well-developed countries into the preparation of appropriate policies at state and local levels. The priority goals were as a rule: source reduction, separated waste collection, recycling, re-use of waste and its safe and reliable removal. In the paper, separated waste collection and household waste processing are discussed in detail, whereas the economic aspects were given special consideration. In that regard, the criterion for establishing the economic justification of separated municipal waste collection was proposed, written in the form of a model and empirically tested in the supply areas of the Vrhnika and Borovnica communities. As it is evident form the results of the research the costs of treating separately collected fractions in Waste Management Centres were on average only 0.05 EUR/kg, and 0.08 EUR/kg taking into account the collection and removal costs. The total costs of mixed collection and removal of waste would be 0.15 EUR/kg, being 0.08 EUR/kg more or 2.02 times the amount. Thus, separate collection in this particular case means a saving of 0.08 EUR per kg of the waste disposed in containers. By introduction of additional variables, the model could be expanded from the local to the regional level.
Key words: *municipal waste, separated waste collection, economic aspects*

1. UVOD

Potrebe so gibalo slehernega razvoja. Pri tem pod pojmom potrebe razumemo sleherno željo, ki jo je mogoče uresničiti z materialnimi

1. INTRODUCTION

Needs are the driving force of each kind of progress. Under the notion of need we mean each desire that can be realized by material

sredstvi. Zlasti pri zadovoljevanju materialnih potreb pa vselej naletimo tudi na omejitve, ki nam jih s tem v zvezi postavlja naravno okolje. Razmerje med človekovimi potrebami na eni in naravnim okoljem na drugi strani se na empirični ravni kaže na vseh ravneh. Naraščajoče potrebe povzročajo pospešeno porabo naravnih dobrin in s tem (v ekonomskem smislu) povečujejo njihovo relativno omejenost, po drugi strani pa povzroča pospešena proizvodnja dobrin negativne stranske učinke, kot so hrup, onesnaževanje in odpadki različnih vrst in v različnih količinah. Te posledice zadovoljevanja človekovih potreb nastopajo, na žalost, v pozitivni medsebojni odvisnosti: čim večje in čim raznovrstnejše so potrebe, tem večja je, posledično, poraba naravnih dobrin, ki se na koncu v obliki odpadkov zopet pojavijo v okolju. Obseg in zaloge naravnih virov se na ta način zmanjšujejo pospešeno.

Nevarnosti nerazsodnega ravnanja z okoljem in naravnimi viri se je razviti del svetovne populacije zavedal že v začetku druge polovice prejšnjega stoletja. Teza o ničelni rasti, ki se je kasneje, predvsem po zaslugi velekapitala, preobrazila v tezo o trajnostnem razvoju, je tako dobila mesto v številnih mednarodnih deklaracijah in varstvo okolja je postalo priljubljena tema najprej razumnikov, kasneje pa tudi politikov in v zadnjem času vedno bolj tudi gospodarstvenikov.

V tej zgodbi eno od navedenih mest zavzema tudi ravnanje s komunalnimi odpadki, tj. z odpadki iz gospodinjstev in sorodnimi odpadki.

Vzrokov za enormno naraščanje količine komunalnih odpadkov je več. V drugi polovici prejšnjega stoletja je postalo potrošništvo vrednota in načina življenja in družbe se je oprijel vzdevek »potrošniška«. V ZRN uporabljajo celo izraz »Wegwerfgesellschaft«, ki je sicer težko prevedljiv, pomeni pa »družbo, ki živi v blagostanju in ki veliko stvari (predmetov, izdelkov, dobrin), ki bi jih lahko še kdaj uporabila, preprosto zavrže in kupi nove« (Deutsches Wörterbuch, 1989). Razlog za tako ravnanje je na osebni ravni gotovo nečimrnost, na gospodarski ravni pa želja po dobičku. Pospeševale pa so ga tudi

means. However, when fulfilling the material needs we always come against limitations set by natural surroundings. The relationship between human needs on one side and natural surroundings on the other reveals itself empirically at all levels. The ever growing needs are the cause of accelerated use of natural goods, which is the cause of (economic) increase of their relative restrictiveness; on the other hand the growing production of goods causes negative side effects, such as noise, pollution and waste of all kind and of different mass. The effects of satisfying the human needs are, sadly, evident in a positive interdependence: the bigger and more diverse the needs, the higher the use of environmental goods, which, as the end result, re-appear in the environment. The extent and stock of natural resources is in this way increasingly reduced.

The developed world has become aware of the dangers of reckless treatment of the environment and natural resources as early as in the beginning of the second half of the last century. The thesis on zero growth, which later – primarily owing to big capital – transformed into the thesis on sustainable development, thus found its place in many international declarations, while environmental protection became the popular subject matter of intellectuals and later of politicians and recently also of businessmen.

One such issue relevant to this story is the treatment of municipal waste, that is, treatment of household and similar waste.

There are several reasons for the enormous increase of the mass of municipal waste. In the second part of the previous century consumption became a value and the way of life, while the society was termed "consumer society". In the Federal Republic of Germany the term "Wegwerfgesellschaft" ("throw-away society") was coined, which is difficult to translate, meaning something like "a society living in prosperity, which simply discards things (objects, products, goods), which could be re-used, but instead buys new ones" (Deutsches Wörterbuch, 1989). Surely, the reasons for such conduct at the personal level are vanity, and, at the economic level, the

neustrezne politike na državni in še posebej na lokalni ravni, ki so eksterne stroške odlaganja odpadkov preprosto socializirale, namesto da bi jih internalizirale. V zadnji četrtini prejšnjega stoletja je postal problem ravnanja z vsemi vrstami odpadkov tako pereč, da je prisilil posamezne, predvsem razvitejše države v oblikovanje ustreznih politik na državni in lokalni ravni.

Prioritetni cilji teh politik pa so praviloma (Runge, 1994; Barata, 2002):

1. Zmanjševanje odpadkov na izvoru.
2. Ločeno zbiranje, reciklaža in vnovična uporaba.
3. Varno in zanesljivo odstranjevanje (uničenje) odpadkov s sežiganjem ali odlaganjem.

Na empirični ravni imajo našteti ukrepi verjetno ravno obratni vrstni red, saj je treba najprej varno in zanesljivo odstraniti že obstoječe (nastale) odpadke in šele v naslednjih korakih, lahko tudi vzporedno, vzpodbujati zmanjševanje količine odpadkov na izvoru ali pa kasneje z ločenim zbiranjem in predelavo.

V prispevku od naštetih ukrepov podrobneje obravnavamo le ločeno zbiranje in predelavo odpadkov, s poudarkom na obravnavi predvsem ekonomskih vidikov.

2. RAVNANJE S KOMUNALNIMI ODPADKI V REPUBLIKI SLOVENIJI

V Republiki Sloveniji (22.000 km^2 površine; 1,96 mio preb.) je bilo po stanju leta 2001 vključenih v redno zbiranje in odvoz komunalnih odpadkov 93 % prebivalcev, ki so odložili skupaj 840.000 ton komunalnih odpadkov, kar pomeni v povprečju *430 kg* na prebivalca letno (ARSO, 2001). V primerjavi sosednjo državo Avstrijo, ki je primerljiva s Slovenijo (84.000 km^2, 8,3 mio prebivalcev), je ta količina razmeroma majhna, saj povzroči v tej državi vsak prebivalec 560 kg komunalnih odpadkov letno, kar je 1,30-krat več kot v Sloveniji. Za boljšo predstavo lahko pogledamo podatke nekaterih ostalih držav. Na Danskem prebivalec letno povzroči 1,53-krat več komunalnih odpadkov kot v Sloveniji (660 kg), v Švici 1,51-krat (650 kg), na Norveškem 1,44-krat (620 kg), v Veliki Britaniji in Irski

desire for profit. This was accompanied by inadequate policies at state and especially local levels, which socialized, instead of internalized, the external costs of waste disposal. In the last quarter of the previous century the problem of treatment of all kinds of waste became so pertinent that it forced some more developed states into shaping appropriate policies at state and local levels.

As a rule, the priority goals of these policies are (Runge, 1994; Barata, 2002):

1. Source reduction.
2. Separated waste collection, recycling and re-use.
3. Safe and reliable removal (destruction) of waste by incineration and disposal.

At the empirical level the measures are probably taken in reverse order, since first the existing (produced) waste should be safely and reliably removed and, in the next step or simultaneously, the reduction of waste should be encouraged – at the source or later through separated waste collection and processing.

Among the measures mentioned, the article deals in detail with separated waste collection and processing, with an emphasis on economic aspects.

2. MUNICIPAL WASTE TREATMENT IN THE REPUBLIC OF SLOVENIA

In the Republic of Slovenia (surface area of 22,000 km^2, population of 1.96 million) in 2001 93% of inhabitants were included into regular collection and removal of municipal waste, who together disposed of 840,000 tonnes of municipal waste, which is on average 430 kg of waste per inhabitant per year (ARSO, 2001). In comparison to the neighbour state of Austria, which can be compared to Slovenia (area of 84,000 km^2, population 8.3 million), this quantity is relatively small, the quantity of waste in Austria being 560 kg of municipal waste per inhabitant yearly, which is 1.30 times more than in Slovenia. For illustration, we can have a look at several other countries. In Denmark, the inhabitant yearly produces 1.53 times more municipal waste than in Slovenia (660 kg), in

1,30-krat (560 kg), v Belgiji 1,28-krat (550 kg), v Nemčiji 1,26-krat (540 kg), v Franciji, Italiji ter na Finskem pa se letna količina odpadkov na prebivalca približa slovenskemu povprečju (med 460 in 510 kg) (EOCD, 2002). Kljub temu da količina komunalnih odpadkov na prebivalca v naši državi še nima tako širokih razsežnosti, smo na tem področju sprejeli kar nekaj pomembnih strateških dokumentov in normativnih aktov na državni ravni. Glede strateških dokumentov velja omeniti predvsem strateške usmeritve (1996) in nacionalni program varstva okolja (1999). Pri normativnih ureditvah je treba na prvem mestu omeniti (prvi) zakon o varstvu okolja (1993) ter na njegovi podlagi izdane: Pravilnik o ravnanju z odpadki (1998, 2000 in 2001), Navodilo za oblikovanje cen (2001) ter Uredbo o taksi za obremenjevanje okolja zaradi odlaganja odpadkov (2004 in 2007).

Glavne strateške usmeritve in cilji glede ravnanja z odpadki se v Sloveniji ne razlikujejo od ciljev, ki smo jih navedli kot vzorčne že v uvodnem poglavju. Edina razlika je pravzaprav v tem, da smo morali v naši državi najprej sanirati obstoječe stanje, saj smo bili pogosto soočeni s takim načinom ravnanja s komunalnimi odpadki, ki so ga poznali stari Rimljani že pred 2500 leti, to je z odlaganjem odpadkov na odprta smetišča.

Poleg sanacije obstoječega stanja je bil drugi pomemben strateški cilj ravnanja s komunalnimi odpadki zmanjšanje odloženih količin že nastalih odpadkov na deponijah in s tem nižanje njihovega nevarnostnega potenciala. K temu so na normativni ravni veliko pripomogli: Pravilnik o ravnanju z odpadki iz leta 1998, Pravilnik o ravnanju z embalažo in odpadno embalažo ter Odredba o ravnanju z ločeno zbranimi frakcijami, na ekonomski ravni pa Uredba o taksi za obremenjevanje okolja zaradi odlaganja odpadkov iz leta 2001.

Pravilnik o ravnanju z odpadki zahteva, da je treba odpadke predelati, če za predelavo obstajajo tehnične rešitve in možnosti nadaljnje uporabe predelanih odpadkov ali njihovih sestavin. Predelati jih ni treba, če so stroški predelave nesorazmerno višji od stroškov njihove odstranitve ali če njihovo odstranjevanje manj obremenjuje okolje kot

Switzerland 1.51 times (650 kg), in Norway 1.44 times (620 kg), in Great Britain and Ireland 1.30 times (560 kg), in Belgium 1.28 times (550 kg), in Germany 1.26 times (540 kg), and in France, Italy and Finland the yearly quantity of waste per inhabitant is close to the Slovene average (between 460 and 510 kg) (EOCD, 2002). Despite the fact that the quantity of municipal waste per inhabitant in Slovenia is still well below the volume mentioned, there were several important strategic and regulatory documents prepared at the state level. In relation to the strategic documents, strategic policies (1996) and the National Environmental Action Programme (1999) should be emphasized, and among regulatory arrangements, the (first) Environment Protection Act (1993) and other related documents: Rules on the management of waste (1998, 2000 and 2001), Instructions for the formation of prices (2001) and Decree on the waste disposal tax (2004 and 2007).

The main strategic directives and goals in relation to waste treatment in Slovenia are no different to those set as exemplary in Introduction. The only difference is that in Slovenia, we first had to rehabilitate the existing state, since quite often the treatment of waste was the same as the one known in the Roman times 2500 years ago, i.e. waste was disposed to open disposal sites.

Besides the rehabilitation of the existing state the other important strategic goal of waste treatment was the reduction of disposed waste on landfills and thus reduction of their danger potential. At the regulation level the following documents provided a significant contribution: the Rules on the management of waste (1998), Rules on management of packaging and packaging waste, the Order on the management of separately collected fractions, and, at the economic level, Decree on the waste disposal tax (2001).

The Rules on the management of waste lay down that waste is processed if there are technical solutions and possibilities of further use of the processed waste or its components. The processing is not required if the processing costs are disproportionately higher than the costs of their removal or if the removal poses a less severe threat to the environment than processing, primarily in

njihova predelava, predvsem glede na emisije snovi in energije, porabo naravnih virov in vsebnosti nevarnih snovi. Prav tako ima uporaba odpadkov kot gorivo prednost pred drugimi načini predelave, če manj od drugih obremenjuje okolje.

Pravilnik o ravnanju z embalažo in odpadno embalažo, ki ga je leta 2006 zamenjala Uredba o ravnanju z embalažo in odpadno embalažo, določa, da imajo ponovna uporaba, recikliranje, energetska predelava in drugi načini predelave odpadne embalaže prednost pred njenim odstranjevanjem, če to omogočajo tehnologije in postopki, ki so v praksi uspešno preizkušeni in so na trgu dostopni ter ne povzročajo nerazumno višjih stroškov, kot bi jih povzročilo odstranjevanje.

Uredba o ravnanju z ločeno zbranimi frakcijami določa, da se morajo pri opravljanju javne gospodarske službe iz celotnega snovnega toka komunalnih odpadkov izločiti ločene in nevarne frakcije. V ta namen je treba zagotoviti ustrezne prostore in opremo v zbiralnicah ločenih frakcij in/ali v zbirnih centrih. Ločeno je treba na ta način zbirati: papir, lepenko ter embalažo iz stekla, plastike, sestavljenih materialov in embalažo iz kovin.

Uredba o taksi za obremenjevanje okolja zaradi odlaganja odpadkov določa, da se ta dajatev plačuje za odpadke, ki se odložijo na odlagališču odpadkov. Zakonodajalec jih imenuje tudi ostanek odpadkov. Ostanek zato, ker se za predhodno ločeno zbrane frakcije ta taksa ne plačuje. Pri dani ceni za enoto obremenitve (kg odloženih odpadkov) je znesek premosorazmeren s količino odloženih odpadkov.

Taksa za obremenjevanje okolja zaradi odlaganja odpadkov predstavlja pomemben finančni vir za financiranje zmanjševanja obremenjevanja okolja in pomemben ekonomski instrument za doseganje zastavljenih in predpisanih ciljev, predvsem za zmanjševanje količine odpadkov pri izvoru, odlaganje čim manjših količin in čim bolj inertnih odpadkov, zmanjševanje količine deleža biološko razgradljivih odpadkov, pospeševanje ločenega zbiranja posameznih frakcij komunalnih odpadkov in postopno večanje obsega obdelave in izrabe odpadkov.

Normativne zahteve na eni in ekonomske

relation to the emission of substances and energy, use of natural resources and content of dangerous substances. If the processing causes a lower level of nuisance to the environment, the use of waste as fuel has advantages over other ways of processing.

The Rules on management of packaging and packaging waste, replaced by Decree on the management of packaging and packaging waste in 2006, lay down that re-use, recycling, energy processing and other ways of processing of packaging waste have advantage over its removal if that is made possible by technologies and procedures, which are successfully tested in practice and available on the market, and do not cause disproportionately higher costs than would be the costs of their removal.

The Order on the management of separately collected fractions lays down that in performing public utility service the separated and dangerous fractions should be eliminated from the entire flow of substances of municipal waste. For this purpose proper space and equipment in the collection sites of separated fractions and/or in collection centres should be ensured. Separated collection of the following waste is necessary: paper, paperboard and packaging material made of glass, plastic, composed materials and metals.

The Decree on the waste disposal tax lays down that the tax is paid for the waste disposed at landfills. This waste is called residual waste by the legislator. “Residual” because the tax is not paid for preliminarily separately collected fractions. At the given price for a unit of load (kg of disposed waste) the price is in direct proportion with the mass of disposed waste.

The waste disposal represents an important financial source for financing the reduction of environmental nuisance and an important economic tool for reaching the goals set and prescribed, primarily for source reduction of waste, minimization of disposal, disposal of inert wastes, reduction of the mass of biodegradable waste, acceleration of separated waste collection of single fractions of municipal waste and gradual increase of the scope of processing and utilization of waste.

The statutory requirements on one hand and economic initiatives on the other hand should

vzpodbude na drugi strani bi seveda morale pospešiti proces ločenega zbiranja in izločanja določenih vrst odpadkov iz celotnega snovnega toka komunalnih odpadkov in s tem povzročiti zmanjšanje količine odpadkov, ki jih odložimo na deponijah. Ali to dejansko drži, razglabljamo v naslednjem poglavju.

3. LOČENO ZBIRANJE IN IZLOČANJE POSAMEZNIH VRST KOMUNALNIH ODPADKOV

3.1 TRENUTNE RAZMERE

Podobno kot na področju prometa in prometne politike velja tudi na področju politike ravnanja z odpadki paradigma, da je najboljši (beri najcenejši) odpadek tisti, ki ga ni. V tej paradigmi je treba iskati razlog, zakaj je prva prioriteta sleherne politike, ki zadeva ravnanje z odpadki, zmanjševanje odpadkov na izvoru. Toda kot je ljudi težko prepričati, da naj hodijo peš ali s kolesom, ker je to bolj zdravo, jih bo težko prepričati, da naj za potrebe popoldanskih nakupov nesejo s seboj v službo prazne steklenice in že uporabljene vrečke. Na empirični ravni se je ta resnica razodela tudi avtorjem, ki so se s problemom zmanjševanja odpadkov na izvoru ukvarjali že v devetdesetih letih prejšnjega stoletja (Runge, 1989; 1994). Sleherna restriktivnejša politika v smislu zapovedi ali prepovedi pa bi na tem področju takoj zadela ob realne interese gospodarskih lobijev.

Kratkoročno nam tako ostane druga možnost glede zmanjševanja količine odpadkov, tj. ločeno zbiranje, izločanje in predelava že nastalih (obstoječih) odpadkov, za kar imamo (tudi) v naši državi pripravljen in sprejet normativni in ekonomski instrumentarij.

Stopnja izločenih komunalnih odpadkov iz deponij skozi povečanje vnovične uporabe materialov in kompostiranja nastopa v razvitem svetu kot pomemben politični gonilnik. Pri tem predstavljata v Evropi močno spodbudo Direktiva o odpadkih (2006/12/ES) in Direktiva o embalaži in odpadni embalaži (94/62/ES, sprememba 2005/20/ES), ki predvidevata obveznosti načrtovanja gospodarjenja z odpadki, ter Direktiva o odlaganju odpadkov na odlagališčih (99/31/ES), ki postavlja cilje za izločanje

accelerate the process of separated collection and elimination of certain types of waste from the entire substance flow of municipal waste, and thus result in the reduction of the mass of the waste disposed of in the landfills. In the next chapter it will be discussed if this is really the case.

3. SEPARATE WASTE COLLECTION AND ELIMINIATION OF CERTAIN TYPES OF WASTE

3.1 CURRENT SITUATION

Similarly to transport and transport policies the following paradigm of waste treatment policy is applicable: the best (i.e. cheapest) waste is the one that does not exist. This is why the first priority of each waste treatment policy is source reduction. However, as hard as it may be to convince people to walk more or use a bicycle for health reasons, it is similarly hard to convince them to bring along empty bottles and used bags for their afternoon shopping. At the empirical level, this has been confirmed by several authors who dealt with issues of source reduction in the 1990's (Runge, 1989; 1994). Each more restrictive policy in the sense of dos and don'ts in the field would quickly come against real interests of economic lobbies.

In short term, the other option of reducing the mass of waste is more feasible, i.e. separated waste collection, elimination and processing of produced (existing) waste, which is in Slovenia well-supported by adopted regulatory and economic instruments.

The diversion of municipal solid waste from landfill through increased materials recycling and composting is an important policy driver throughout the developed world. In Europe, much of the impetus is provided by the Directive (2006/12/EC) on waste and Directive (2005/20/EC amending Directive 94/62/EC) on packaging and packaging waste, which provide obligations of planning waste management, and Directive (99/31/EC) on the landfill of waste, which sets tough targets for the diversion of biodegradable organic waste

biorazgradljivih organskih odpadkov iz deponij.

Državne politike predlagajo glede obsega izločanja in predelave komunalnih odpadkov določene kazalce in ciljne vrednosti, s pomočjo katerih potem ocenjujejo učinkovitost sprejetih ukrepov.

Tako ministrstvo za okolje ameriške zvezne države Vermont vsako leto določi t. i. vermontsko stopnjo izločenih komunalnih odpadkov (Malus, 2004). Ta je določena z razmerjem med količinami odpadkov, ki se reciklirajo, znova uporabijo ali kompostirajo, in celotno količino nastalih (povzročenih) komunalnih odpadkov.

V R Sloveniji je leta 2001 stopnja izločenih komunalnih odpadkov znašala 9 %, čeprav ločeno zbiranje komunalnih odpadkov izvaja že 70 % izvajalcev javnih gospodarskih služb (Ibidem). V občinah Vrhnika in Borovnica pa je znašala ta stopnja leta 1998 41 %, leta 2002 pa 56 % (Eržen, 2003). Naj na tem mestu še omenimo, da je bil v strateških usmeritvah Republike Slovenije, ki smo jih pripravili leta 1996, zastavljen cilj, po katerem naj bi že do leta 2000 dosegli zmanjšane količine odloženih komunalnih odpadkov za 30–45 %.

In zakaj predvidenih stopenj na državni ravni niti približno ne dosegamo, na lokalni ravni pa smo jih v nekaterih primerih presegli že predčasno? Odgovorov je verjetno več, kot je več tudi razlogov. A med pomembnejšimi so gotovo ekonomski. O njih več v nadaljevanju.

3.2 STROŠKOVNI VIDIKI RAVNANJA S KOMUNALNIMI ODPADKI

Ravnanje s komunalnimi odpadki, tj. zbiranje, odvoz, predelava, odstranjevanje, je povezano s stroški. Ti so pri danih cenah in pri dani produktivnosti produkcijskih faktorjev, ki sodelujejo v tem procesu, odvisni od vrste odpadkov in njihove količine, prav tako pa tudi od načina in stopnje njihove obdelave oziroma predelave. V tej luči je treba presojati tudi ekonomsko upravičenost ločenega zbiranja in predelave odpadkov.

Za lažje razumevanje prikazujemo v nadaljevanju tehnologijo in stroškovne posledice ločenega in mešanega zbiranja komunalnih odpadkov (slika 1).

Pri mešanem zbiranju komunalnih odpadkov celotna količina odloženih odpadkov v zabojnike ali druge posode za odlaganje odpadkov konča na deponiji ali na

from landfills.

in relation to the scope of elimination and processing of municipal waste state policies suggest certain indicators and goal values, which help estimate the efficiency of adopted measures.

The Ministry of the environment of US state Vermont each year specifies the so called Vermont Diversion Rate of municipal waste (Malus, 2004). This is calculated from the ratio between the mass of waste being recycled, reused or composted, and the entire mass of waste produced.

In the Republic of Slovenia the estimated diversion rate of municipal waste in 2001 was 9%, even though 70% of public utility services have introduced separated waste collection (Ibidem). In the communities of Vrhnika and Borovnica the rate was 41% in 1998, and as much as 56% in 2002 (Eržen, 2003). It should be mentioned that the strategic objectives of the Republic of Slovenia, prepared in 1996, included the goal to reduce the mass of disposed municipal waste by 30–45%.

Why is it that at the state level the planned rate is far from being reached while at the local level it has in some cases been exceeded at an even earlier stage? Probably, there are several answers and several reasons. However, the most important are probably the economic ones, which will be discussed in more detail.

3.2 COST ANALYSIS OF MUNICIPAL WASTE TREATMENT

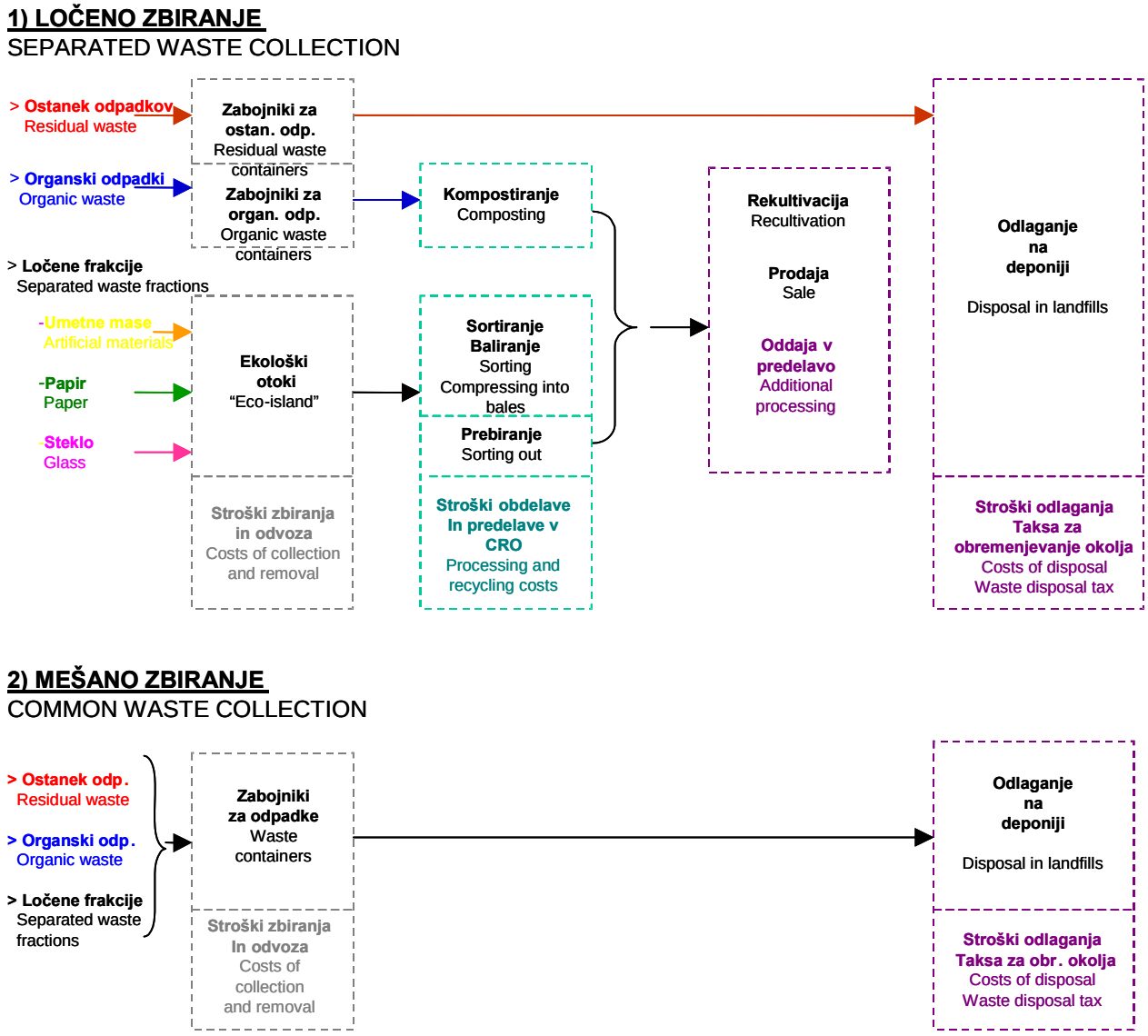
Municipal waste treatment, i.e. collection, transportation, processing, removal, involves costs. These are at the given prices and productivity of production factors involved in the process, dependent upon the type of waste and mass, as well as the way and rate of their processing, respectively. In this respect one needs to assess the economic justification of separated waste collection and processing.

For illustration, the technology and consequences in terms of costs of separated and mixed municipal waste collection are shown (Figure 1).

With mixed collection of municipal waste the entire mass of disposed waste into waste containers or other type of containers ends up

drugem mestu za končno odstranjevanje odpadkov. Celotne stroške ravnanja s komunalnimi odpadki sestavljata v tem primeru dve značilni skupini, in sicer: stroški zbiranja in odvoza in stroški odlaganja. Pri slednjih predstavlja v naši državi pomembno sestavino tudi taksa za obremenjevanje okolja (slika 1).

at the landfill or other site for end-disposal of waste. The entire costs of municipal waste treatment are composed of two characteristic groups: costs of collection and removal, and costs of disposal. In relation to the latter costs, in Slovenia the Waste Disposal Tax has been an essential element (Figure 1).



Slika 1. Tehnologija in stroški ravnanja z odpadki, po mestu nastanka.
Figure 1. Waste management and costs according to the place of origin.

Pri ločenem zbiranju komunalnih odpadkov pa konča na deponiji samo tisti del komunalnih odpadkov (ostanek odpadkov), ki se jih predhodno ne predela (kompostira, balira, reciklira) in proda kot končne produkte ali odda v nadaljnjo obdelavo, praviloma odplačno, kot surovine ali polproizvode. V tem primeru sestavljajo celotne stroške ravnanja s

In separated municipal waste collection the landfill is met only with waste (residual waste) that is not processed (composted, baled or recycled) and sold as end product or forwarded into further processing, as a rule against payment, as raw products or intermediate products. In this case the entire costs of

komunalnimi odpadki poleg stroškov zbiranja in odvoza ter stroškov odstranjevanja odpadkov še stroški obdelave in predelave ločeno zbranih odpadkov v centrih za ravnanje z odpadki (CRO) – (slika 1). V kolikor predelane (obdelane, reciklirane) odpadke v CRO prodamo ali oddamo v nadaljnjo predelavo odplačno, se nam v podjetniškem smislu stroški predelave zmanjšajo za navedeni izkupiček. V tem primeru govorimo o t. i. *saldiranih stroških*. Lahko pa je izkupiček od prodaje celo večji od stroškov predelave. V tem primeru izkazuje faza predelave komunalnih odpadkov v podjetniškem smislu dobiček.

Razmerje med (saldiranimi) stroški predelave in prihrankom stroškov pri odlaganju in odstranjevanju komunalnih odpadkov predstavlja enega od temeljnih kriterijev pri opredeljevanju ekonomske upravičenosti ločenega zbiranja in predelave odpadkov. O tem bomo nekoliko podrobneje spregovorili v naslednjem poglavju.

4. EKONOMSKA UPRAVIČENOST LOČENEGA ZBIRANJA IN PREDELAVE KOMUNALNIH ODPADKOV

4.1 OPREDELITEV PROBLEMA

V Republiki Sloveniji smo ravnanje s komunalnimi odpadki v normativnem smislu opredelili kot obvezno lokalno gospodarsko javno službo. Ena od temeljnih značilnosti gospodarskih javnih služb pa je, da je pri njih ustvarjanje dobička podrejeno zadovoljevanju potreb. Praviloma bi se morala torej izvajati dejavnost ravnanja s komunalnimi odpadki kot neprofitna dejavnost, katere temeljna naloga bi morala biti redno zbiranje in odvoz vseh vrst komunalnih odpadkov iz naselij in njihova končna dispozicija v skladu s predpisanimi ekološkimi in drugimi standardi. Toda tudi pri neprofitnih dejavnostih veljajo zakoni ekonomike in ekonomske učinkovitosti, le da se tu ekonomska učinkovitost meri in ugotavlja drugače kot pri profitnih dejavnostih. Za razliko od profitnih dejavnosti, kjer želi zasebnik predvsem maksimirati profit, želimo pri neprofitnih dejavnostih – pri danem obsegu in kakovosti storitev – predvsem minimizirati

municipal waste treatment are made of – in addition to collection and removal costs and costs of disposal – costs of working and processing of separated waste collection in Waste Management Centres (Figure 1). If the processed (worked, recycled) waste in the Centres are sold or subcontracted into further processing against payment, economically, the processing costs are reduced for the proceeds. In that respect we use the term balanced costs. However, the proceeds from the sale may be higher than the processing costs. In such case the processing phase of municipal waste is economically beneficial.

The ratio between (balanced) costs and cost savings in disposal and removal of municipal waste represents one of the basic criteria in establishing the economic justification of separated waste collection and processing. This will be further discussed in the next chapter.

4. ECONOMIC JUSTIFICATION OF SEPARATED WASTE COLLECTION AND PROCESSING

4.1 DEFINITION OF THE PROBLEM

In the Republic of Slovenia municipal waste treatment has been regulated as the compulsory local utility service. One of the basic characteristics of utilities is that profit making is subject to satisfaction of needs. As a rule, the service of municipal waste treatment should be performed as a non-profit activity, with a basic goal of regular collection and removal of all kind of waste from settlements and its final disposal in accordance with the prescribed ecological and other standards. However, non-profit activities are also governed by the laws of economics and economic efficiency, only that the economic efficiency is measured and established differently than with revenue-generating activities. In comparison to the profit-making activities where the private owner primarily wants to maximize his profit, in non-profit-making activities – at the given scope and quality in service – the goal is to minimize

stroške. Pri danem (predpisanem) obsegu in kvaliteti izvajanja in zagotavljanja storitev bo v ekonomskem smislu učinkovitejša tista dejavnost (izvajalec, tehnologija), ki bo na dolgi rok izkazovala nižje narodnogospodarske stroške na enoto produkta oziroma storitve.

Povedano velja tudi za sisteme ravnanja s komunalnimi odpadki: ločeni sistem zbiranja, odvoza in predelave komunalnih odpadkov bomo izbrali samo v primeru, ko nam bo na dolgi rok izkazoval nižje skupne stroške na m^3 zbranih, odpeljanih in odstranjenih komunalnih odpadkov kot mešani sistem. Ta pogoj pa bo dosežen le v primeru, *ko bodo prihranki pri stroških odlaganja in končne odstranitve komunalnih odpadkov višji kot stroški predelave, obdelave in reciklaže ločeno zbranih odpadkov*. Stroške in prihranke razumemo v tem primeru v narodnogospodarskem in ne zgolj v podjetniškem smislu.

4.2 FORMALNI ZAPIS MODELA

Kriterij glede ekonomske upravičenosti uvajanja ločenega zbiranja in predelave komunalnih odpadkov, kot smo ga predstavili v razdelku 4.1, lahko zapišemo tudi v obliki modela. Ločeno zbiranje in predelava posameznih vrst komunalnih odpadkov bosta v ekonomskem smislu upravičena, če bo veljal naslednji zapis:

costs. At the given (prescribed) scope and quality of performance and insurance of service, the activity providing lower costs in the long term at the national/economic level per unit of product or service will be economically more efficient.

This also holds true for systems of municipal waste treatment: the separated system of collection, transportation and processing of municipal waste will be chosen only if in the long run the total costs per m^3 of collected, removed and disposed municipal waste will be lower than with the mixed system. This condition will be met only *when the saving of disposal costs and end-disposal of municipal waste will be higher than the costs of working, processing and recycling of separately collected waste*. In this case, the costs and savings are to be understood from the national/economic point of view, not only from the entrepreneurship point of view.

4.2 FORMULATION OF THE MODEL

The criterion of economic justification of introducing separated waste collection and processing of municipal waste, as proposed in section 4.1, can be expressed in the form of a model. Separated collection and processing of different types of municipal waste will be economically justified, if the following is applied:

$$\left[\left(C_{COL,RW}+C_{DSP,RW}\right)+\left(C_{COL,FR}+C_{CRO,FR}+C_{DSP,FR}\right)\right]-\left[P_{FR}\right]<\left[C_{COL,T}+C_{DSP,T}\right] \quad (1)$$

Pri tem mora veljati še:

The following must also apply:

$$Q_T = Q_{RW} + \sum_{i=1}^{n} Q_{FRi} \quad (2)$$

$$P_{FR} = \sum_{i=1}^{n} P_{FRi} \quad (3)$$

$$C_{i,j} = \overline{C}_{i,j} Q_{i,j} \quad (4)$$

Opredelitev spremenljivk in njihovih dimenzij:
Oznaka Naziv (enota)
i ……...vrsta ločeno zbrane frakcije [-]
j……..…..vrsta komunalnega odpadka [-]
Q_T…….količina vseh komunalnih odpadkov [kg]
Q_{RW}……...količina ostanka komunalnih odpadkov [kg]

Q_{FR}……..količina ločeno zbrane frakcije komunalnih odpadkov [kg]
TC……skupni stroški ravnanja s komunalnimi odpadki [EUR]
$C_{COL,\,i,\,j}$….stroški zbiranja in odvoza posamezne vrste odpadkov [EUR]
$C_{DSP,\,i,\,j}$….stroški deponiranja in odstranitve posamezne vrste odpadkov [EUR]
$C_{CRO,\,i,}$…..stroški ravnanja s posamezno frakcijo v CRO [EUR]
$\overline{C}$ ……..stroški na utežno enoto odpadkov [EUR/kg]
P_{FR}……prihodki iz prodaje (oddaje) predelanih in recikliranih frakcij [EUR]

Definition of variables and their dimensions:
Symbol *Name* [*unit*]
i …… type of separately collected fraction [-]
j……..…...type of municipal waste [-]
Q_T……. mass of all municipal waste [kg]
Q_{RW}……..mass of residual municipal waste [kg]
Q_{FR}…….. .mass of separately collected fractions of municipal waste [kg]
TC……total costs of municipal waste treatment [EUR]
$C_{COL,\,i,\,j}$… costs of collection and removal of single type of waste [EUR]
$C_{DSP,\,i,\,j}$….costs of disposal at landfills and removal of particular type of waste [EUR]
$C_{CRO,\,i,}$ …..costs of treatment with single fractions in Waste Management Centres [EUR]
$\overline{C}$ ……..costs per weight unit of waste [EUR/kg]
P_{FR}……revenue from selling (subcontracting) the processed and recycled fractions [EUR]

4.3 EMPIRIČNI TEST MODELA NA OSKRBNEM OBMOČJU VRHNIKA–BOROVNICA

4.3.1 Opis območja in sistema ravnanja s komunalnimi odpadki

Predlagane kriterije in model za ekonomsko upravičenost ločenega zbiranja in predelave komunalnih odpadkov smo empirično preverili na območju občine Vrhnika in Borovnica (170 km^2, 21.300 prebivalcev), kjer izvaja dejavnost ravnanja s komunalnimi odpadki Komunalno podjetje Vrhnika d.d. (nadaljevanju KPV). V zbiranje in odvoz so vključeni vsi prebivalci obravnavanih občin. S pripravami na ločeno zbiranje komunalnih odpadkov so v KPV pričeli že leta 1994, uvedli pa so ga leta 1995. Leta 1997 so na delu deponije uvedli Center za ravnanje z odpadki (CRO), kjer kompostirajo biorazgradljive organske odpadke ter obdelujejo (sortirajo, stiskajo, balirajo) ostale vrste ločeno zbranih odpadkov na ekoloških otokih (papir, steklo, umetne mase). Ostanek odpadkov vozijo na deponijo v sosednjo občino Logatec.

Uvedbo sistema ločenega zbiranja in predelave komunalnih odpadkov so od leta

4.3 EMPIRICAL TEST OF THE MODEL IN THE SUPPLY AREA OF VRHNIKA–BOROVNICA

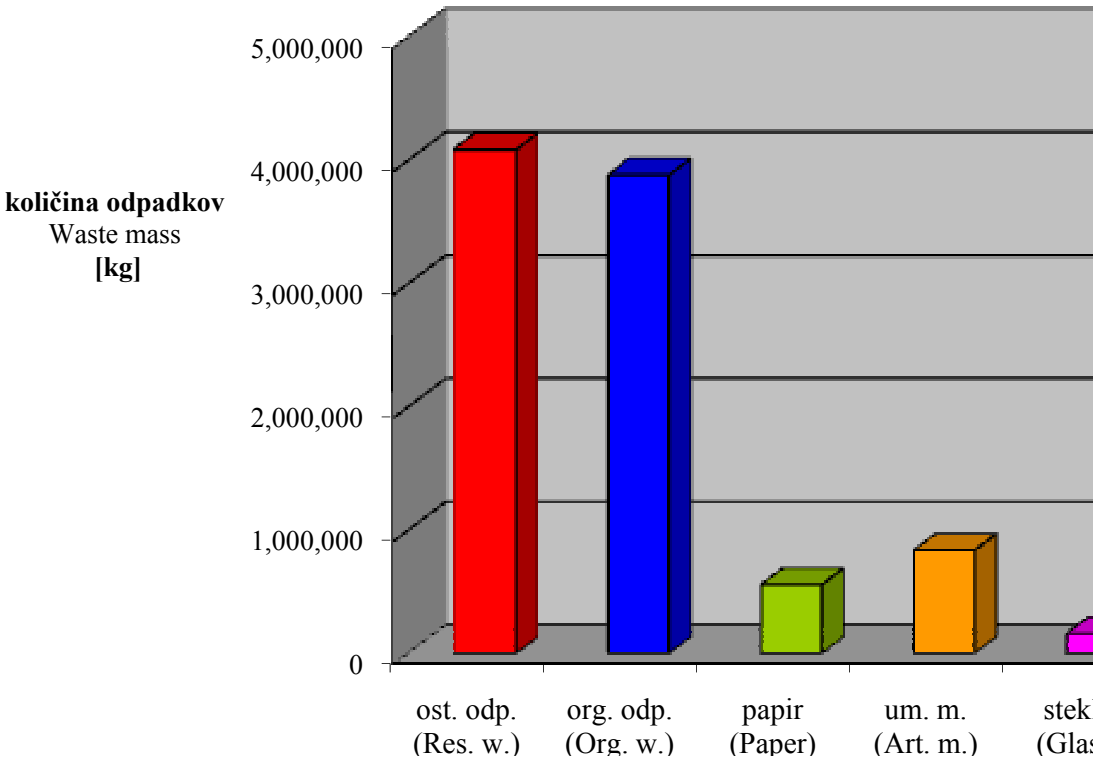
4.3.1 Description of the area and the system of municipal waste treatment

The proposed criteria and model for economical justification of separated collection and processing of municipal waste was empirically tested in the area of communities of Vrhnika and Borovnica (170 km^2, population of 21,300), where the municipal waste treatment service is performed by the municipal enterprise (hereafter KPV). The entire population of the two communities is included into collection and removal of waste. In KPV, the preparations for separate municipal waste collection first started in 1994, and it was fully introduced in 1995. In 1997 a Waste Management Centre was established on the landfill site, where biodegradable organic waste is disposed and other types of separately collected waste in ecological islands (paper, glass, artificial materials) are processed (sorted, pressed, baled). The residual waste is transported to the neighbouring community of Logatec.

Since 1994, the introduction of the system

1994 dalje stalno oglaševali in promovirali v medijih in tudi na druge načine. Odziv pri občanih je presegel vsa pričakovanja, saj je znašala stopnja izločevanja že prvo leto 40 %, v letu 2002 pa se je povzpela že na 55 %, kar je šestkrat (!) več, kot znaša povprečje za celotno državo (glej poglavje 3.1).

of separated municipal waste collection and processing was continuously advertised and promoted in media and otherwise. The response of the local inhabitants exceeded all expectations; thus the diversion rate after the first year was 40%, and in 2002 it reached as much as 55%, which is six times (!) the average state-wide rate (see Chapter 3.1).



Slika 2. Prikaz količine in strukture komunalnih odpadkov iz gospodinjstev, zbranih v občinah Vrhnika in Borovnica v letu 2002.

Figure 2. Mass and structure of municipal household waste, collected in Vrhnika and Borovnica communities in 2002.

Preglednica 1. Količina in struktura komunalnih odpadkov iz gospodinjstev, zbranih v občinah Vrhnika in Borovnica v letu 2002.

Table 1. Mass and structure of municipal household waste, collected in Vrhnika and Borovnica communities in 2002.

skupina odpadkov – *Group of waste*	leta 2002 zbrana količina – *Waste collected in 2002*
ostanek odpadkov – *Residual waste* (20 03 01)	**4.084.128 kg**
organski odpadki – *Organic waste* (20 01 08)	**3.882.000 kg**
papir – *Paper* (20 01 01)	**546.000 kg**
umetne mase – *Artificial materials* (20 01 39, 20 01 40))	**839.000 kg**
steklo – *Glass* (20 01 02)	**157.000 kg**
kosovni odpadki – *Bulk rubbish* (20 03 07)	**146.000 kg**
skupaj – *Total*	**9.654.128 kg**

Opomba: s klasifikacijsko številko odpadkov iz klasifikacijskega seznama odpadkov (EWC)
Note: with the classification number of waste from the European Waste Catalogue and Hazardous Waste List

Količino in strukturo komunalnih odpadkov na obravnavanem območju nam za leto 2002 kažeta preglednica 1 in slika 2.

4.3.2 Ocena posameznih vrst stroškov in prihodkov

Sistem ravnanja s komunalnimi odpadki smo v tehnološkem in kasneje v finančnem smislu razdelili na naslednje faze:

1. Zbiranje in odvoz komunalnih odpadkov.
2. Ravnanje s komunalnimi odpadki v CRO (Centru za ravnanje z odpadki).
3. Deponiranje ostanka odpadkov in oddaja ločenih frakcij v predelavo.

Pri *zbiranju in odvozu* komunalnih odpadkov smo upoštevali: stroške ločenega zbiranja ostanka odpadkov pri gospodinjstvih ($C_{COL,RW}$), stroške zbiranja koristnih odpadkov na ekoloških otokih (papir, umetne mase in steklo) in njihovega odvoza v predelavo ($C_{COL,FR}$) in stroške osveščanja in obveščanja občanov (*public relations*).

Pri ravnanju s komunalnimi odpadki v CRO (C_{CRO}) smo upoštevali stroške prebiranja in sortiranja ločeno zbranih koristnih odpadkov z ekoloških otokov ter stroške kompostiranja biološko razgradljivih odpadkov na kompostarni.

Pri *stroških deponiranja* (C_{DSP}) smo upoštevali stroške obratovanja deponije in stroške odvoza ločeno zbranih odpadkov v predelavo oziroma njihovega uničenja.

Vsakega od navedenih vrst stroškov smo ocenili v skladu z veljavnim navodilom za oblikovanje cen storitev obveznih lokalnih gospodarskih javnih služb. Skupne stroške smo v naslednji fazi razdelili na posamezne značilne skupine komunalnih odpadkov (organski, steklo, papir, umetne mase, ostanek komunalnih odpadkov) z uporabo ustreznih delitvenih količnikov (deležev), kot so: količinski delež posamezne vrste odpadkov, delež obratovalnih ur vozil in strojev, delež opravljenih delovnih ur zaposlenih po izobrazbi in plačilnih razredih, delež vrednosti osnovnih sredstev, ipd. Uporaba te metodologije je bila v tem konkretnem primeru možna v prvi vrsti zato, ker nam je vodstvo KPV dovolilo in omogočilo dostop in uporabo ne samo agregiranih finančnih

The mass and structure of municipal waste in the area for 2002 is illustrated in Table 1 and Figure 2.

4.3.2 Estimate of single types of costs and revenue

The system of municipal waste treatment was in the technological and later in financial sense divided into the following phases:

1. Collection and removal of municipal waste.
2. Municipal waste treatment in Waste Management Centres.
3. Disposal of residual waste and delivery of separated fractions into processing.

With *collection and removal* of municipal waste the following was taken into account: costs of separated collection of residual household waste ($C_{COL,RW}$), costs of collecting beneficial waste in ecological islands (paper, artificial materials and glass) and its transportation into processing ($C_{COL,FR}$), and costs of raising public awareness and information (*public relations*).

With municipal waste treatment in Waste Management Centres (C_{CRO}) the costs of screening and sorting of separately collected beneficial waste from ecological islands and costs of composting of biodegradable waste at the composting facility were considered.

With *costs of disposal at landfills* (C_{DSP}) the costs of operation of landfill and transportation costs of separately collected waste into processing and their destruction were considered.

Each type of costs was assessed in accordance with the current Instructions on the forming prices of mandatory local public services. The total costs were in the next phase divided into single characteristic groups of municipal waste (organic, glass, paper, artificial materials, residual municipal waste) by the use of appropriate dividing ratios, such as: mass ratio of each group of waste, ratio of operational hours of vehicles and machines, education and (payment) grade, the ratio of value of fixed asset etc. The application of the methodology on the concrete example was primarily made possible because the KPV management enabled access and use of not only aggregated financial data, but also of

podatkov, ampak tudi druge finančne in fizične podatke in kazalce iz svojih poslovnih knjig in evidenc. Brez tako kvalitetnih in razčlenjenih finančnih in tehničnih podatkov ta raziskava gotovo ne bi bila mogoča.

Podatke o realiziranih prihodkih od prodaje kompostiranih organskih odpadkov ter od oddaje papirja, pločevink in stekla v nadaljnjo predelavo smo *(P_{FRI})* dobili neposredno iz poslovnih knjig.

other financial and physical data and indices from their books and business records. Without itemised financial and technical data of such quality this study would not be possible.

The data on the effected revenue from sale of composted organic waste and from delivery of paper, cans and glass into further processing *(P_{FRI})* were obtained directly from their business records.

5. REZULTATI IN RAZPRAVA

Ocenjeni skupni in saldirani stroški ravnanja s komunalnimi odpadki so po mestu nastanka (zbiranje in odvoz, obdelava in predelava, odlaganje in odstranitev) ter po vrstah komunalnih odpadkov (ločeno zbrane frakcije, ostanek komunalnih odpadkov) prikazani v preglednici 2, povprečni stroški pa v preglednici 3 in na sliki 3. V preglednicah in diagramu so upoštevani zgolj komunalni odpadki iz gospodinjstev, katerih količine so navedene v preglednici 1, v poglavju 4.3.1.

5. RESULTS AND DISCUSSION

Table 2 shows the estimated total and balanced costs of municipal waste treatment according to the place of origin (collection and removal, working and processing, disposal and destruction) and type of municipal waste (separately collected fractions, residual waste). Average costs are illustrated in Table 3 and Figure 3. In the tables and figure only household municipal waste is considered; the mass of household waste is given in Table 1, Chapter 4.3.1.

Preglednica 2. Skupni in saldirani stroški ravnanja z gospodinjskimi odpadki v EUR.
Table 2. Total and balanced costs of household waste management in EUR.

skupina odpadkov *Waste group*	strošek zbiranja in odvoza *Costs of collection and removal*	strošek ravnanja v CRO *Processing and recycling costs*	stroški deponiranja, takse *Costs of disposal, waste disposal tax*	skupni stroški ravnanja z odpadki *Total costs of waste management*	prihodek oddaje odp. v predelavo *Incomes of delivery to additional processing*	saldirani stroški *Balanced costs*
	[EUR]	[EUR]	[EUR]	[EUR]	[EUR]	[EUR]
ost. odp. *Residual w.*	138,199	22,363	322,813	483,371	-	**483,371**
org. odp. *Organic w.*	55,650	127,145	-	182,799	28,960	**153,839**
papir *Paper*	48,460	33,045	-	81,506	18,177	**63,328**
um. mase *Artif. mater.*	18,219	59,790	-	78,009	647	**77,362**
steklo *Glass*	34,581	16,249	-	50,830	300	**50,534**
skupaj *Total*	295,109	258,592	322,813	876,515	48,085	**828,434**

Opomba: Zaradi zaokroževanja nastajajo odstopanja pri seštevkih.
Note: Due to rounding off there might be deviations in the total sums.

Preglednica 3. Povprečni stroški ravnanja z gospodinjskimi odpadki.
Table 3. Average costs of household waste management.

skupina odpadkov *Waste group*	strošek zbiranja in odvoza *Costs of collection and removal*	strošek ravnanja v CRO *Processing and recycling costs*	stroški deponiranja, takse *Costs of disposal, waste disposal tax*	skupni stroški ravnanja z odpadki *Total costs of waste management*	prihodek oddaje odp. v predelavo *Incomes of delivery to additional processing*	saldirani stroški *Balanced costs*
	[EUR/kg]	[EUR/kg]	[EUR/kg]	[EUR/kg]	[EUR/kg]	[EUR/kg]
ost. odp. *Residual w.*	0.06	-	0.12	0.18	-	**0.18**
org. odp. *Organic w.*	0.03	0.06	-	0.09	0.01	**0.07**
papir - *Paper*	0.15	0.10	-	0.25	0.06	**0.20**
um. mase *Artif. mater.*	0.09	0.29	-	0.38	0.01	**0.38**
steklo - *Glass*	0.24	0.11	-	0.36	0.01	**0.35**

Opomba: Zaradi zaokroževanja nastajajo odstopanja pri seštevkih.
Note: Due to rounding off there might be deviations in the total sums.

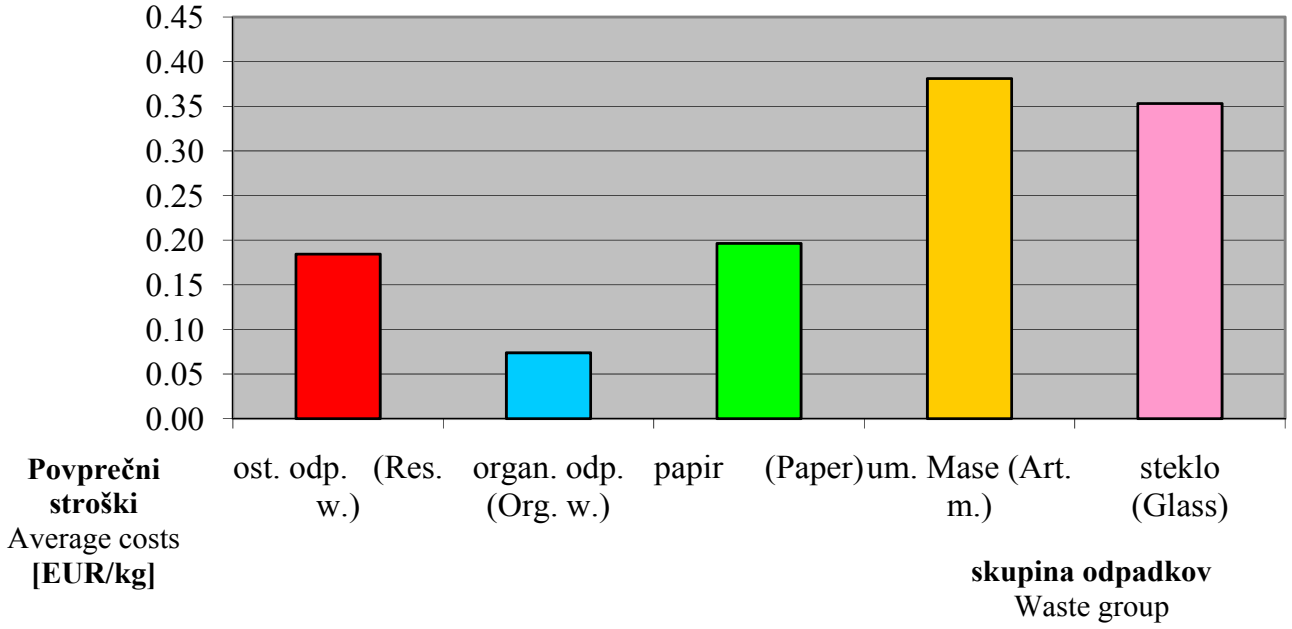
Preglednica 4. Zbirni prikaz posameznih vrst povprečnih stroškov.
Table 4. Summary review of average costs.

skupina odpadkov *Waste group*	strošek zbiranja in odvoza *Costs of collection and removal*	strošek ravnanja v CRO *Processing and recycling costs*	stroški deponiranja, takse *Costs of disposal, waste disposal tax*	skupni stroški ravnanja z odpadki *Total costs of waste management*
	[EUR/kg]	[EUR/kg]	[EUR/kg]	[EUR/kg]
ostanek odpadkov *Residual waste*	0.06	-	0.12	**0.18**
izločene frakcije *Diversion waste*	0.03	0.05	-	**0.08**
skupaj odpadki *Total waste quantity*	0.03	0.05	0.12	**0.15**

Opomba: Zaradi zaokroževanja nastajajo odstopanja pri seštevkih.
Note: Due to rounding off there might be deviations in the total sums.

Na obravnavanem območju občin Vrhnika in Borovnica so začeli z ločenim zbiranjem komunalnih odpadkov iz čisto ekonomskih razlogov. Deponijski prostor je bil zapolnjen, stroški deponiranja ($\overline{C}_{DSP}$) v sosednji občini Logatec pa so znašali skupaj s takso za obremenjevanje okolja 0,12 EUR/kg (preglednici 3 in 4).

In the area of Vrhnika and Borovnica communities separated municipal waste collection was initiated from purely economic reasons. The landfill site was filled and the costs of disposal (C_{DSP}) in the neighbouring community of Logatec together with the Waste Disposal Tax amounted to 0.12 EUR/kg (Tables 3 and 4).



Slika 3. Prikaz povprečnih (saldiranih) stroškov ravnanja z gospodinjskimi odpadki.
Figure 3. Average (balanced) costs of household waste management.

Zbirni podatki v preglednici 4 nam kažejo, da so stroški ravnanja z ločeno zbranimi frakcijami v CRO (C_{CRO}) znašali v povprečju le 0,05 EUR/kg, s stroški zbiranja in odvoza vred pa 0,08 EUR/kg. Pri mešanemu načinu zbiranja in odvoza komunalnih odpadkov bi znašali skupni stroški ravnanja ($\overline{C}\,T$) 0,15 EUR/kg, kar pomeni za 0,08 EUR/kg oziroma 2,02-krat več. Ločeno zbiranje pomeni v konkretnem primeru torej 0,08 EUR prihranka na vsak kg odloženih odpadkov v zabojnike. Poudarjamo, v konkretnih razmerah. Če bi namreč, hipotetično vzeto, obravnavani občini lahko odlagali svoje odpadke na deponiji v Ljubljani, kjer znaša povprečen strošek odlaganja le 0,03 EUR/kg (Malus, 2004), bi ločeno zbiranje in predelava komunalnih odpadkov izgubilo – z vidika direktnih stroškov – svoje ekonomsko opravičilo. V tem primeru bi bili stroški ravnanja z ločeno zbranimi frakcijami v CRO ($\overline{C}_{CRO}$) 1,88-krat višji kot stroški deponiranja na deponiji v Ljubljani (Stroški prevoza odpadkov do deponije v Ljubljani pri tem niso upoštevani.)

Drugačno sliko glede ekonomske upravičenosti ločenega zbiranja in predelave komunalnih odpadkov v CRO dobimo tudi, če ločeno zbranih frakcij ne obravnavamo skupaj, ampak vsako posebej. Rezultati v preglednici nam kažejo, da bi bilo v tem primeru (z vidika

Summary data in Table 4 show that the costs of treating separately collected fractions in Waste Management Centres (C_{CRO}) were on average only 0.05 EUR/kg, and 0.08 EUR/kg taking into account the collection and removal costs. The total costs of mixed collection and removal of waste would be ($\overline{C}\,T$) 0.15 EUR/kg, being 0.08 EUR/kg more or 2.02 times the amount. Thus, separate collection in this particular case means a saving of 0.08 EUR per kg of the waste disposed in containers. The emphasis is on this particular case. Hypothetically, if the communities could dispose their waste at the landfill in Ljubljana, where the average cost of disposal is only 0.03 EUR/kg (Malus, 2004), the separate waste collection and processing would lose its economic justification from the point of view of direct costs. In such case the costs of treating separately collected fractions in the Centres ($\overline{C}_{CRO}$) would be 1.88 times higher than the costs of disposal at the landfill in Ljubljana (The costs of transportation of waste to the landfill in Ljubljana are not considered.)

Furthermore, a different situation in terms of economic justification of separate collection and processing of municipal waste in the Centres is obtained if the separately collected fractions are dealt with separately rather than

samo direktnih stroškov) ekonomsko upravičeno ločeno zbirati in obdelovati samo organske odpadke, kjer znašajo skupni stroški ravnanja 0,09, saldirani pa le 0,07 EUR/kg. Pri vseh ostalih ločeno zbranih frakcijah pa celo saldirani stroški ravnanja presegajo stroške mešanega načina zbiranja, ki bi znašali, kot smo izračunali, 0,15 EUR/kg (glej preglednico 3 in sliko 4). K nižjim stroškom in upravičenosti ravnanja z ločenimi frakcijami prispevajo v konkretnem primeru predvsem organski odpadki. Brez njihove udeležbe bi bili zaključki precej drugačni.

Seveda pa na podlagi doslej povedanega ne smemo zaključiti, da ločeno zbiranje in ravnanje z izločenimi frakcijami praviloma nima svojega ekonomskega opravičila. Ne pozabimo, doslej smo govorili le o direktnih stroških deponiranja, pri čemer se z njihovo strukturo in višino nismo posebej ukvarjali. Kljub temu lahko z na gotovost meječo verjetnostjo trdimo, da v izkazanih stroških ni upoštevana amortizacija naložbenih stroškov v deponijo, vsaj ne v realni višini.

Ekonomsko upravičenost ločenega zbiranja komunalnih odpadkov je treba iskati predvsem v prihranku deponijskega prostora. Na stroškovni strani pomeni prihranek prostora v fizičnem smislu (m^3) prihranek na direktnih (investicijskih) stroških in prihranek na indirektnih stroških. Prvega občutijo predvsem povzročitelji odpadkov, in to na račun nižjih cen ravnanja s komunalnimi odpadki, drugega pa posredno ali neposredno vsi subjekti na vplivnem območju deponijskega objekta. Pri iskanju lokacij za deponije igrajo odločilno vlogo ravno negativni stranski učinki in s tem povezani merljivi in nemerljivi posredni stroški. Pri tem imamo v mislih v prvi vrsti turbulence, ki jih povzroči predvidena lokacija deponije pri okoliških prebivalcih ter dolgotrajnost in negotovost postopka pri sprejemanju ustreznega prostorskega akta (t. i. »stroški demokracije«). V prihodnosti je treba v zvezi s prostorsko umestitvijo in izgradnjo deponijskega objekta računati tudi na obveznost plačila odškodnin prizadetim subjektom zaradi zmanjšane uporabne vrednosti nepremičnin, zmanjšanje kakovosti bivalnega okolja ter zaradi zmanjšane vrednosti nepremičnin in izgubljenega

together. The results in the table show that in this case (by looking at direct costs only) it is economically justifiable to collect separately and process only organic waste, where total treatment costs are 0.09, and balanced costs 0.07 EUR/kg only. In all other separately collected fractions even the balanced costs of treatment exceeded the costs of mixed collection, which would be 0.15 EUR/kg, based on our calculations (see Table 3 and Figure 4). Organic waste contributes most significantly to lower costs and justification of separate fraction treatment in the particular case. Without organic waste, our conclusions would be quite different.

However, one cannot argue that separate collection and treatment of diversion waste is economically not justified. Let us not forget that so far only direct costs of disposal were discussed, without paying much attention to their structure and height. Despite this, we can maintain with almost certainty that the costs do not include depreciation of investment costs into the landfill, certainly not the real costs of it.

The economic justification of separate waste collection should be sought after primarily in the saving of landfill space. From the aspect of costs the saving of space in the physical sense (m^3) means saving on direct (investment) costs and saving on indirect costs. The first one mainly affects waste producers, owing to the lower prices of waste treatment, and the latter affects, indirectly or directly, all subjects in the impact area of the landfill facility. When searching a landfill location, the decisive role is taken by the negative side effects and related measurable and non-measurable indirect costs. By this we have in mind the turbulence caused by planned landfill location among local inhabitants and the long setup times and uncertainty of procedure during adoption of relevant spatial documents (so called "costs of democracy"). Regarding the spatial placing and building of the landfill site in the future, one will have to consider the obligation of paying compensations to the affected subjects for the reduced quality of the living space and reduced value of real properties and lost profit. (For these types of compensation the term

dobička. (Za te vrste odškodnin se je udomačil izraz »ekološka renta«, čeprav v strokovnem smislu ni popolnoma korekten). Ob navedenih vrstah stroškov (stroški demokracije, odškodnine in nadomestila) je treba upoštevati še stroške rizika zaradi nevarnosti nekontroliranega odtekanja in pronicanja izcednih vod z deponije v podtalnico. Zaradi naštetih vrst posrednih in dodatnih stroškov deponiranja skušajo država in lokalne skupnosti s posameznimi ukrepi zmanjšati količine odpadkov. Eden med njimi je prav gotovo uvedba sistema ločenega zbiranja in predelave odpadkov. V našem primeru pomeni to poleg prihranka na direktnih stroških ravnanja s komunalnimi odpadki v višini 0,08 EUR/kg še prihranek 6.875 m^3 deponijskega prostora letno. Na upravno-operativni ravni pomeni to podaljševanje obratovalne dobe obstoječe deponije in prihranek aktivnosti in stroškov (podjetniških in družbenih) v zvezi z iskanjem lokacije za novo deponijo. Ob tem velja še enkrat poudariti, da je v tem konkretnem primeru ločeno zbiranje in predelava komunalnih odpadkov ekonomsko upravičeno že z vidika (samo) direktnih stroškov.

6. ZAKLJUČKI

V prispevku smo obravnavali upravičenost ločenega zbiranja komunalnih odpadkov predvsem z vidika stroškov. Na podlagi opravljene analize smo ugotovili (v nasprotju s pričakovanji), da se na obravnavanem območju in v konkretnih razmerah (deponiranje komunalnih odpadkov v sosednji občini) ločeno zbiranje in predelava splača že z vidika direktnih stroškov, saj bi bili pri mešanem zbiranju stroški ravnanja s komunalnimi odpadki na utežno enoto (zbiranje, odvoz, deponiranje) ravno še enkrat višji. Z ločevanjem, predelavo in vnovično uporabo ostalih vrst odpadkov (gradbeni odpadki, amortizirana transportna sredstva) se v tem prispevku nismo ukvarjali. Prav tako ne z ločevanjem in odstranjevanjem nevarnih in strupenih odpadkov, kar vse naj bi prinašalo celo milijardne posle (Runge, 1994).

Pri komunalnih odpadkih želimo z njihovim ločenim zbiranjem in nadaljnjo predelavo zmanjšati predvsem potrebo po deponijskem

"ecological rent" has been established, even though the term is not entirely correct in the professional sense.) Next to the types of costs (costs of democracy, compensation and refunds) one needs to take into account the risk costs of uncontrolled run-off and leaking of landfill leachate into groundwater. Due to the kinds of direct and additional costs of disposal, as given above, national and local communities try to use different measures to reduce the quantity of waste. One of the measures is certainly the introduction of a system of separated waste collection and waste processing. In our case, besides saving on direct costs of household waste treatment in the amount of 0.08 EUR per kg, this also means the saving of 6875 m^3 of landfill area per year. On the administrative and operational levels it means the prolongation of the operational period of the existing landfill and saving on activities and costs (entrepreneurial and social) in relation to finding the locations for a new landfill. Furthermore, in this case it should be stressed that the separated waste collection and processing is economically justifiable based on (merely) direct costs.

6. CONCLUSIONS

The paper discusses the justification of separate collection of municipal waste from the aspect of costs. On the basis of the analysis performed it was established (contrary to our expectations) that in the discussed area and under the particular conditions (municipal waste disposal in the neighbouring community) separate waste collection and processing is beneficial even in terms of direct costs of municipal waste treatment, since with mixed collection the treatment costs per weight unit (collection, removal, disposal) would be twice the amount. This paper does not deal with separation, processing and reuse of other types of waste (building waste, depreciated transport means). It also does not deal with separation and removal of dangerous and toxic waste, being massive business (Runge, 1994).

With municipal waste we wish, through separate collection and processing, to reduce

prostoru in s tem v zvezi neposredne in posredne stroške deponiranja. Model, ki je bil s tem v zvezi razvit in empirično preverjen na konkretnem lokalnem nivoju, je možno z upoštevanjem dodatnih kriterijev in spremenljivk razširiti tudi na regijski nivo.

ZAHVALA

Za empirični test predlaganega modela smo uporabili finančne in druge podatke in gradiva Komunalnega podjetja Vrhnika d.d. Podjetju, še posebej pa njegovi sodelavki ga. Maji Gunstek, se ob tej priložnosti najtopleje zahvaljujemo za razumevanje in vsestransko pripravljenost za pomoč.

IZRAZOSLOVJE

Odpadek je vsaka snov oziroma predmet v tekočem, plinastem ali trdnem agregatnem stanju neznanega lastnika ali ki ga proizvajalec, lastnik ali imetnik ne more ali ne želi uporabiti sam, ga ne potrebuje, ga moti oziroma mu škodi ali ga je zaradi interesov varstva okolja oziroma drugega javnega interesa treba obdelati, predelati ali odložiti, kot je predpisano.

Komunalni odpadki so gospodinjski in njim podobni odpadki, ki nastajajo v proizvodnih in storitvenih dejavnostih, v bivalnem okolju ter na površinah in v objektih v javni rabi, ki so pretežno trdi in po svoji sestavi heterogeni, zaradi razpršenosti virov njihovega nastanka in količine na viru pa se ravnanje z njimi zagotavlja na lokalni ravni.

Gospodarjenje z odpadki zajema preprečevanje in zmanjševanje nastajanja odpadkov ter njihovih škodljivih vplivov na okolje in ravnanje z odpadki.

Ravnanje z odpadki zajema zbiranje, prevažanje, predelavo in odstranjevanje odpadkov, vključno s kontrolo tega ravnanja in okoljevarstvenimi ukrepi po zaključku delovanja objekta ali naprave za predelavo ali odstranjevanje odpadkov.

Predelava odpadkov je namenjena koristni uporabi odpadkov ali njihovih sestavin in zajema predvsem reciklažo odpadkov za predelavo v surovine in vnovično uporabo

the need for landfill space and therewith the direct and indirect costs of disposal. By considering the additional criteria and variables, the model that was developed and empirically tested at the concrete local level could be expanded to the regional level.

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For the empirical test of the proposed model we used financial and other data and materials of the municipal enterprise Komunalno podjetje Vrhnika d.d. We wish to express our utmost gratitude to Vrhnika d.d. enterprise and especially to Ms. Maja Gunstek for all the understanding and help.

GLOSSARY

Waste is any substance or object in liquid, gaseous or solid form of unknown owner, where the waste producer, owner or holder cannot or does not wish to use such substance or object himself, does not require it, is inconvenienced or harmed by it, and which for environmental protection purposes or other public benefit must be delivered for processing or disposal, processed or disposed of in the prescribed manner.

Municipal waste is waste from households and other similar waste, which is produced in production and service activities, in the living environment and in areas and objects of public domain, which are mostly solid and heterogeneous in their composition; by reason of the scattered nature of their resources and mass at the resource the handling of waste is ensured at the local level.

Waste management covers the prevention and reduction of waste and their harmful influence on the environment and waste handling.

Waste treatment covers the collection, transportation, processing and disposal of waste, including control of treatment and environmental protection measures following the termination of operation of a facility or appliance for processing and disposal of waste.

Waste processing is intended for the beneficial use of waste or its constituents, and

odpadkov ter uporabo odpadkov kot gorivo v kurilni napravi ali industrijski peči ali uporabo odpadkov za pridobivanje goriva. Sežiganje komunalnih in drugih odpadkov s toplotno obdelavo z namenom njihovega odstranjevanja ni predelava odpadkov.

Ločene frakcije so ločeno zbrane frakcije, ki niso nevarni odpadki in na katere se nanaša s to odredbo določen najmanjši obseg oskrbe.

Ostanki komunalnih odpadkov so komunalni odpadki, iz katerih so izločene ločeno zbrane frakcije, ali ostanki iz predelave ločeno zbranih frakcij in kosovnih odpadkov, ki jih zaradi njihove sestave ali načina nastajanja praviloma ni možno razvrstiti v skupino "ločeno zbrane frakcije" ali v druge skupine komunalnih odpadkov ali v skupino "embalaža, vključno z ločeno zbrano embalažo, ki je komunalni odpadek" v klasifikacijskem seznamu odpadkov iz predpisa o ravnanju z odpadki.

Prevzemno mesto komunalnih odpadkov je mesto, kjer povzročitelji komunalnih odpadkov prepuščajo po vnaprej določenem urniku izvajalcu javne službe komunalne odpadke v temu namenjenih zabojnikih. Prevzemno mesto komunalnih odpadkov se za posamezno stavbo določi ob začetku uporabe storitev službe prevzemanja komunalnih odpadkov.

Zbirno mesto komunalnih odpadkov je mesto, kjer so nameščene posode za ločeno zbiranje odpadkov, v katere povzročitelji odpadkov neovirano ločeno odlagajo odpadke.

Center za ravnanje z odpadki (CRO) je prostor, kjer se sprejemajo odpadki, ki jih pripeljejo izvajalci javne službe, občani ali pravne osebe z lastnim prevozom. Organski odpadki se kompostirajo. PET-embalažo in papir se sortira, balira in skupaj z ostalimi ločenimi frakcijami začasno skladišči. Koristne ločene frakcije se oddajo v nadaljnjo predelavo, ostanek odpadkov pa se stehta in odpelje na deponijo.

covers primarily recycling of waste for processing into raw materials, the re-use of waste and the use of waste as fuel in heating appliances and industrial furnaces or the use of waste for the recovery of fuel. The incineration of urban and other waste through thermal treatment with the intention of disposal of the waste is not deemed to be waste processing.

Separated waste fractions are separately collected fractions, which are non-hazardous waste and to which the least scope of supply relates to in accordance with the Decree on the management of separately collected fractions in the public service of urban waste management.

Residual municipal waste is municipal waste, from which the separated waste fractions or residuals from the processing of separated waste fractions and bulk waste are eliminated, which due to their composition and way of forming cannot be categorized into group “separated waste fractions” or into other groups of municipal waste or group “packaging, including separately collected packaging, which is municipal waste” laid down in the Classification List of Waste in the Rules on waste management.

Reception point of municipal waste means a place, where the producers of municipal waste surrender their waste according to schedule to municipal waste collector in designated containers. The reception point of municipal waste is determined for each building at the start of using the service of municipal waste collectors.

Collection point of municipal waste means a place in which one or more containers for separated collection of waste are situated, where producers of waste dispose of their (separated) waste without restriction.

A **waste management centre** is a place where waste is delivered by the public service, citizens or legal persons with their own transport. Organic waste is composted. Returnable packaging and paper are sorted, baled and put into temporary storage together with other separated fractions. Useful separated fractions are forwarded into further processing, and residual waste is weighed and transported to the landfill.

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