Hungary-Croatia
Cross-border Co-operation Programme

Interreg
European Regional Development Fund
EUROPEAN UNION

2REGIONS
2SUSTAIN

Development of Waste Management Systems in View of the Circular Economy

Study on the Opportunities for Further Cooperation
Between Hungary and Croatia in the Area of Waste Management



Prepared by: BIOKOM Nonprofit Kft., with the participation of My Connection Nonprofit Kft.

Pécs, September 2018

The analysis was produced as part of the 2REGIONS2SUSTAIN HUHR/1601/3.1.1/0032 project, within the framework of the Hungary-Croatia Cross-Border Cooperation Programme, co-financed by the European Regional Development Fund and Hungary.

This document was realised with the co-financing of the European Union. BOKOM Nonprofit Kft. is exclusively responsible for its contents. The materials displayed here cannot be considered to reflect the official position of the European Union and/or the HU-HR Interreg V-A CBC Programme Managing Authority.

UNIKOM
BIOKOM Nonprofit Kft.
REGIONALNA RAZVOJNA AGENCIJA SLAVONIJE I BARANJE
Pécsi Városfejlesztési Nonprofit Zrt.

Table of Contents

1. Legal Context 4

1.1. European waste management situation and regulation 4

1.1.1. Waste Framework Directive (2008/98/EC) 5

1.1.2. Directive 94/62/EC on packaging and packaging waste 7

1.1.3. Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste 9

1.1.4. Waste Generation and Treatment in Europe 10

1.1.5. Needs of the European Industry 15

1.1.6. Circular economy in the EU 17

1.2. Hungarian waste management plans and strategies 18

1.2.1. Development Concept of National Municipal Solid Waste Management 19

1.2.2. National Waste Management Plan 2014-2020. (Government Decision 2055/2013 (XII. 31.) on the National Waste Management Plan) 21

1.2.3. Regional Waste Management Plans and Regional Prevention Programmes 24

1.2.4. Public Waste Collector Waste Management Plan 26

1.2.5. National Collection and Recovery Plan 26

1.2.6. National Waste Management Public Service Plan (NWMPSP) 27

1.3. Hungarian laws and regulations 29

1.3.1. Act LXXXV of 2012 on Waste 29

1.3.2. Act LXXXV of 2011 on Environmental Tax on Products 31

1.4 Croatian Waste Management Plans and Strategies 34

1.4.1. Waste Management Strategy of the Croatian Republic 34

1.4.2. Croatian Waste Management Plan for the 2017-2022 Period 36

1.5 Croatian Act on Waste Management 38

2. Description of current waste management systems 40

2.1. Hungarian public service situation, in particular situation of the BIOKOM Group/Dél-Kom Ltd. 40

2.1.1. The situation and problems of the waste management public service system 40

2.1.2. Catalysts of the integration process 46

2.1.3. Financing of the public service system 49

2.1.4. Major factors in the establishment of optimum public service regions 57

2.1.5. The situation of the public service activities of Dél-KOM Nonprofit Ltd. until 2016 59

2.1.6. Integration of Dél-Kom Nonprofit Ltd. in 2017 64

2.1.7. Evaluation of the integration of Dél-Kom Nonprofit Ltd 71
2.2. Technical data of the Pécs area waste management 74
2.2.1 Logistics and infrastructural background of waste collection and treatment 74
2.2.2 Waste streams 79
2.3. Croatian public service situation 87
2.3.1. Area supplied 87
2.3.2 Measures for Separate Waste Collection 89
2.3.3. Finances 93
2.3.4. Education 93
3. Recommendations for Development and Cooperation 95
3.1 Development options in Hungary 95
3.1.1. Quality improvement of secondary fuels derived from waste and quantitative increase in yields 95
3.1.2. Development of secondary raw material production in material recovery facilities 96
3.1.3. Maximizing the segregated collection and recovery of organic waste 97
3.2 Development options in Croatia 98
3.2.1. Official plans 98
3.2.2. Methodological considerations regarding the establishment of a regional waste treatment centre 99
3.2.3 Developments inspired by the field trip 103
3.3. Cooperation options 103
3.3.1. Regulation of international shipments of waste 103
3.3.2 Options for cooperation on the two sides of the border 105
4. Opportunities for the Creation of Green Jobs 107
4.1. Labour market situation in Baranya 107
4.2. Labour market situation in Osijek-Baranja 111
4.3. Opportunities for Job Creation 112
4.3.1. Processing industry 112
4.3.2. Collection 113
4.3.3. Reuse 118
4.3.4. Waste treatment facilities 119
4.3.5. Training, Raising Awareness, Incubation 119
5. References 121

1. Legal Context

The two countries involved in the project are both members of the European Union, therefore, their legislation must be in line with the EU Directives and Regulations. As a result, in Section 1, in addition to the waste production and treatment overview, the relevant EU and national regulations will be presented.

1.1. European waste management situation and regulation

Waste management policy has evolved rapidly over recent time, as shown in Figure 1. There are two key EU Directives that have greatly influenced waste management practices, the Landfill Directive (EU 1999) and later the Waste Framework Directive (2008/98/EC). Both have a strong focus on reducing the negative impacts of landfill activities on both human health and the environment. They advocate a transition away from disposal of waste and towards more sustainable waste and material management. [1]



Fig. 1: Development of regulation

Legislation affecting waste management in EU:

- ***Directive 2008/98/EC*** of the European Parliament and of the Council of 19 November 2008 on waste, which was amended by Directive (EU) 2018/851 of the European Parliament and of the Council.
- Commission ***Regulation (EU) No 1357/2014*** of 18 December 2014 replacing Annex III to Directive 2008/98/EC of the European Parliament and of the Council on waste.
- Council Directive 94/62/EC on packaging and packaging waste, as amended by Directive (EU) 2018/852 of the European Parliament and of the Council.
- Council ***Directive 1999/31/EC*** of 26 April 1999 on the landfilling of waste, as amended by Directive (EU) 2018/850 of the European Parliament and of the Council.
- Council ***Decision 2003/33/EC*** of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of Annex II to Directive 1999/31/EC. (Not to be confused with European Parliament and Council Directive 2003/33/EC!)
- ***Regulation (EC) No 1013/2006*** of the European Parliament and of the Council of 14 June 2006 on shipments of waste, amended by the ***Regulation (EU) No 660/2014*** of the European Parliament and of the Council of 15 May 2014.

As for European Countries, the following priority objectives for waste policy have to be highlighted (from the ***7th Environment Action Program***):

- Volume reduction of waste.
- Maximization of recycling and re-use activities.
- Limitation of energy recovery (incineration) to non-recyclable materials.
- Limitation of landfilling to non-recyclable and non-recoverable waste.
- Implementation and standardization of the waste policy targets in all Member States.

1.1.1. Waste Framework Directive (2008/98/EC)

Accordingly, the revised ***Waste Framework Directive (2008/98/EC)*** introduced a five-step waste hierarchy.

The waste hierarchy (shown in Figure 2.) places emphasis on reducing waste and maintaining materials as products in order to increase sustainability. The most sustainable option must be preferred. Avoidance of waste, followed by reuse, recycling and then recovery are recommended. Disposal, as the least sustainable practice, must occur as a last resort only.

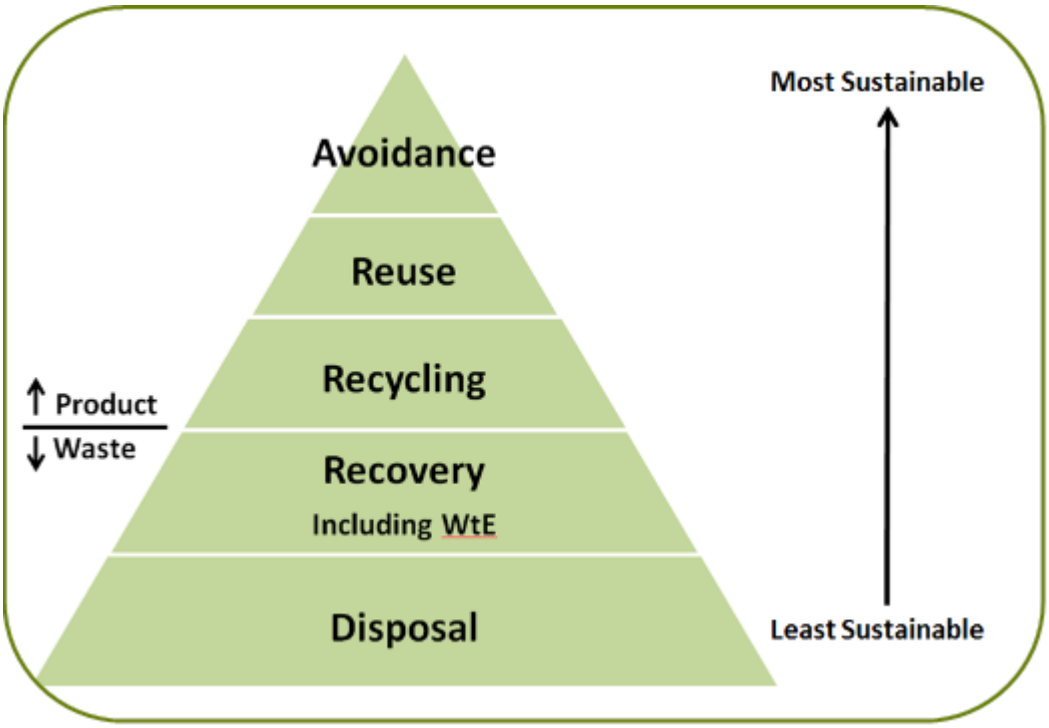


Fig. 2: Waste hierarchy

This concept has become a legal requirement for all Member States as the basis of their waste policy. [1]

One of the objectives of the Waste Framework Directive (2008/98/EC) is to provide a framework for moving towards a European recycling society with a high level of resource efficiency. Its aim is to foster waste management systems that reduce overall impact on the environment and human health. Moreover, these systems are designed to prevent the generation of waste and/or to re-use it. On a long term basis, landfills should disappear, considering that the legislation on waste wants to reduce the disposal of waste in landfills and promote material recycling and energy recovery. Such EU legislation was effective. For example, the separate waste collection with the waste recycling rate has increased year by year, when the waste going to landfills is reduced. One of the objectives set by the ongoing review of the measures of Circular Economy packages is to reduce landfilling to a maximum of 10% of municipal waste by 2030. [13]

The expectations laid down in Directive 2008/98/EC vis-a-vis Hungary in numbers:
By 31.12.2014 glass, paper, plastic and metal shall be subject to separate collection in every single municipality.

By 31.12.2020 50% of the paper, metal, plastic and glass components from MSW (municipal solid waste) generated by households shall be reused or recycled.
Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste supplemented the above as follows:

- By 2025, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 55% by weight;
- By 2030, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 60% by weight;
- By 2035, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 65% by weight.

Under certain conditions a Member State may postpone the deadlines for achieving the targets referred to above. [14]

End-of-Waste criteria

End-of-waste criteria related to the Waste Framework Directive (2008/98/EC) specify when certain waste ceases to be waste and obtains a status of a product (or a secondary raw material). Certain specific waste shall cease to be waste when it has undergone a recovery (including recycling) and complies with specific criteria to be developed in line with certain legal conditions (such as that the substance is commonly used for specific purposes and the use will not lead to overall adverse environmental or human health impacts, and of course there is an existing market or demand for the substance or object). These criteria should be set for specific materials by the Commission.
Joint Research Centre has elaborated a methodology to develop the specific criteria. After having agreed this methodology with the Member States, the Commission is now preparing a set of end-of-waste criteria for priority waste streams. So far, the criteria have been laid down for iron, steel aluminium scrap, glass cullet and copper scrap [15]

1.1.2. Directive 94/62/EC on packaging and packaging waste

Directive 94/62/EC on packaging and packaging wasteset as an objective the prevention and reduction of the environmental impact of packaging and packaging waste and it contains provisions regarding reuse, recycling and recovery. EU minimum expectation: By 31.12.2012 60% recovery, of which a minimum of 55% is material recovery.
Within this:
Recovery of packaging paper waste: 60% material recovery.
Recovery of packaging metal waste: 50% material recovery.

Recovery of packaging plastic waste: 22.5% material recovery.
Recovery of packaging glass waste: 60% material recovery.
Recovery of packaging wood waste: 15% material recovery.

Directive (EU) 2018/852 of the European Parliament and of the Council of 30 May 2018 amending Directive 94/62/EC on packaging and packaging waste supplemented the above with the following requirements:

- no later than 31 December 2025 a minimum of 65% by weight of all packaging waste will be recycled;
- no later than 31 December 2025 the following minimum targets by weight for recycling will be met regarding the following specific materials contained in packaging waste:
    (i) 50% of plastic;
    (ii) 25% of wood;
    (iii) 70% of ferrous metals;
    (iv) 50% of aluminium;
    (v) 70% of glass;
    (vi) 75% of paper and cardboard;
- no later than 31 December 2030 a minimum of 70% by weight of all packaging waste will be recycled;
- no later than 31 December 2030 the following minimum targets by weight for recycling will be met regarding the following specific materials contained in packaging waste:
    (i) 55% of plastic;
    (ii) 30% of wood;
    (iii) 80% of ferrous metals;
    (iv) 60% of aluminium;
    (v) 75% of glass;
    (vi) 85% of paper and cardboard.

While Member States may not request a derogation for all packaging materials and percentages, under certain conditions, a Member State may postpone the deadlines for achieving the above targets by up to five years for certain packaging materials, but

- the derogation is limited to a maximum of 15 percentage points from a single target or divided between two targets;
- as a result of the derogation, the recycling rate for a single target is not reduced below 30%,
- the recycling rate for glass or paper and cardboard shall not be reduced below 60%.

1.1.3. Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste

The main objective of the "***Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste***" (the Landfill Directive) is to ensure that operational and technical requirements on the waste and landfills are in order. Moreover, it provides for measures, procedures and guidance to prevent and/or reduce negative effects on the environment, especially surface and ground water, soil and air pollution. It also includes the greenhouse effect emissions, as well as any possible risk to human health, during the entire life-cycle of the landfill. Furthermore, the Directive defines the different categories of waste (municipal waste, hazardous waste, non-hazardous waste and inert waste) and applies it to all landfills, defined as waste disposal sites for the deposit of waste onto or into land. Since the Council Directive 1999/31/EC, the number of landfills in operation has decreased. On the other hand, the implementation of the directive has increased operational and aftercare costs for sanitary landfills (Hogland et al., 2011).
Directive 1999/31/EC of 26 April 1999 on the landfill of waste introduced two important provisions:

- Reduction of biodegradable waste going to landfills (Article 5).
- Only waste that has been subject to treatment can be landfilled (Article 6, a). [13]

For the reduction of biodegradable waste going to landfills, Directive 1999/31/EC required that the quantity of biodegradable municipal waste going to landfills with municipal solid waste (MSW) be reduced to 35% of the total amount of biodegradable municipal waste produced in 1995. What this meant for Hungary was that by 31 July 2016 the amount had to be reduced to below 820 thousand tons. [16]

The European Innovation Partnership (**EIP) on Raw Material** initiative focuses on promoting innovation in two main areas as:

- Technologies to improve the recovery from waste (e.g. red mud and abandoned or closed mining waste facilities, etc…).
- Turning wastes into valuable SRMs by developing more efficient recycling/recovering processes (e.g. metals recycling from municipal waste, thermochemical phosphorous recovery from incinerated sludge, rare metals recovery from waste electric and electronic equipment, advanced recycling methods for the construction and demolition waste, multi-material cartons and paper waste etc.). This is a key concept to circular economy: The EIP on Raw

Materials' aim is to help raise industry's contribution to the EU GDP to around 20% by 2020. [17]

Furthermore, the European Commission in a Communication (2012) stated that more ought to be done to help reduce the landfilling of materials throughout their life cycle (European Commission, 2012). It is thus clear that existing and future policy will support a comprehensive approach to waste management. [13]

1.1.4. Waste Generation and Treatment in Europe

Figure 3 and 4 show that the per capita amount of municipal waste has only slightly decreased, whereas landfilled municipal waste exhibits a massive decrease between 2000 and 2010 or 2015, on EU-27 level.

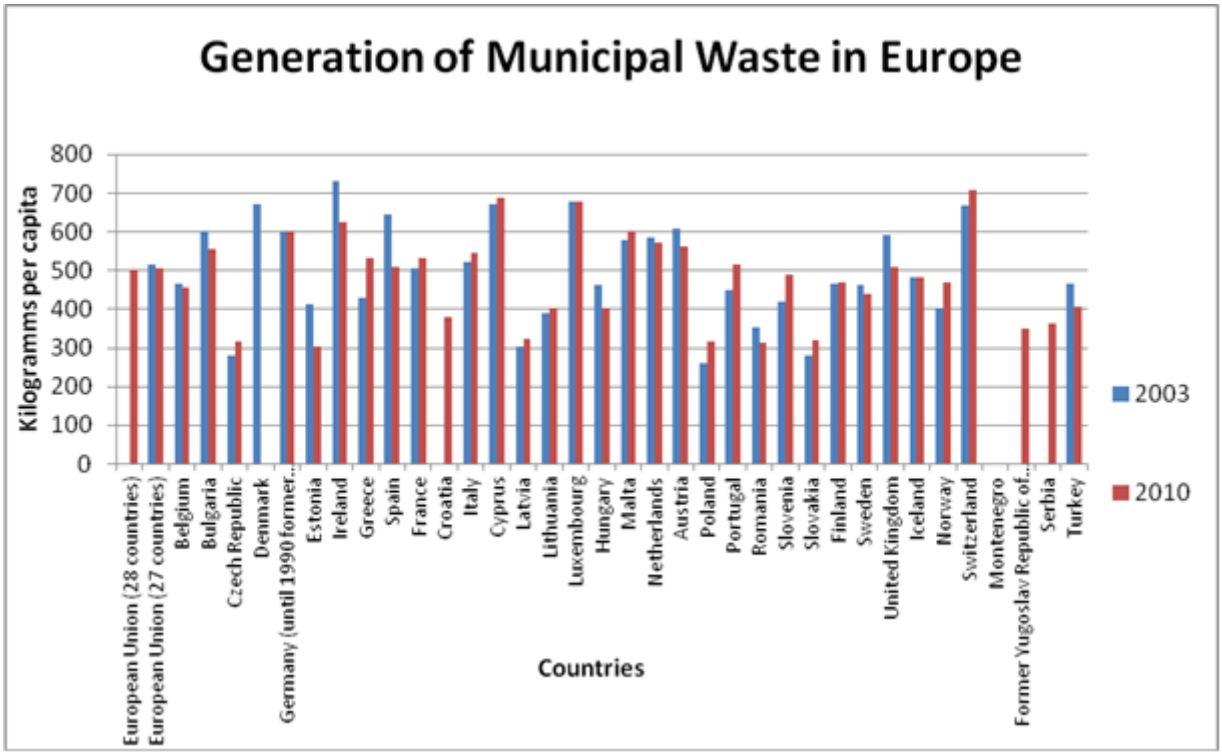


Fig.3.: Generation of Municipal Waste in Europe (Kg/Capita)

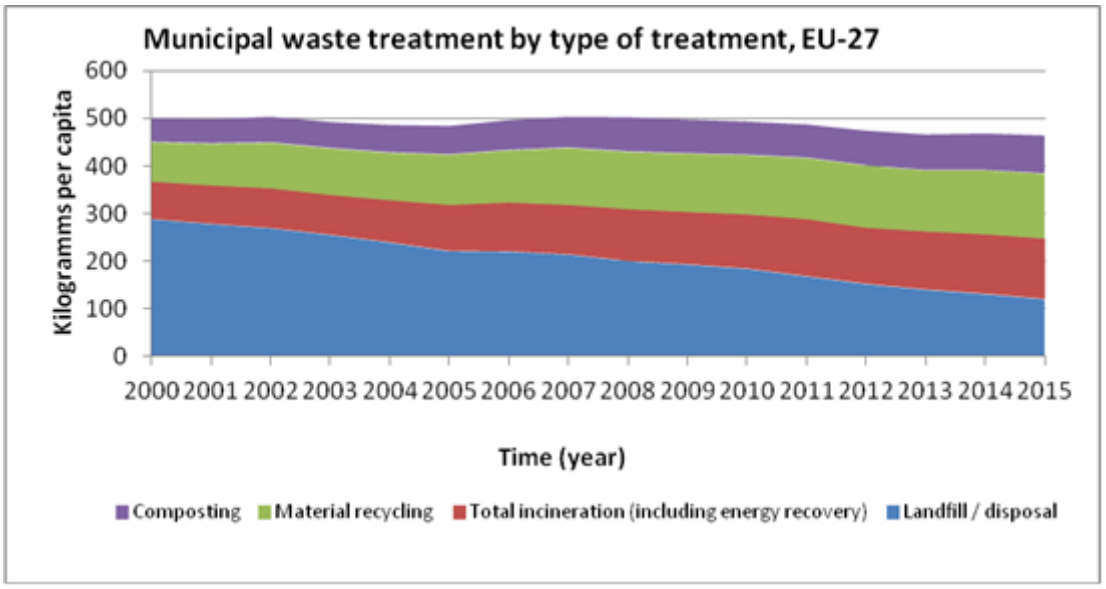


Fig.4.: Municipal Waste Treatment by Type of Treatment, EU-27, (Kg per Capita) (figure prepared by author)

We will use a few illustrative examples to demonstrate the direction waste treatment may take in various countries:

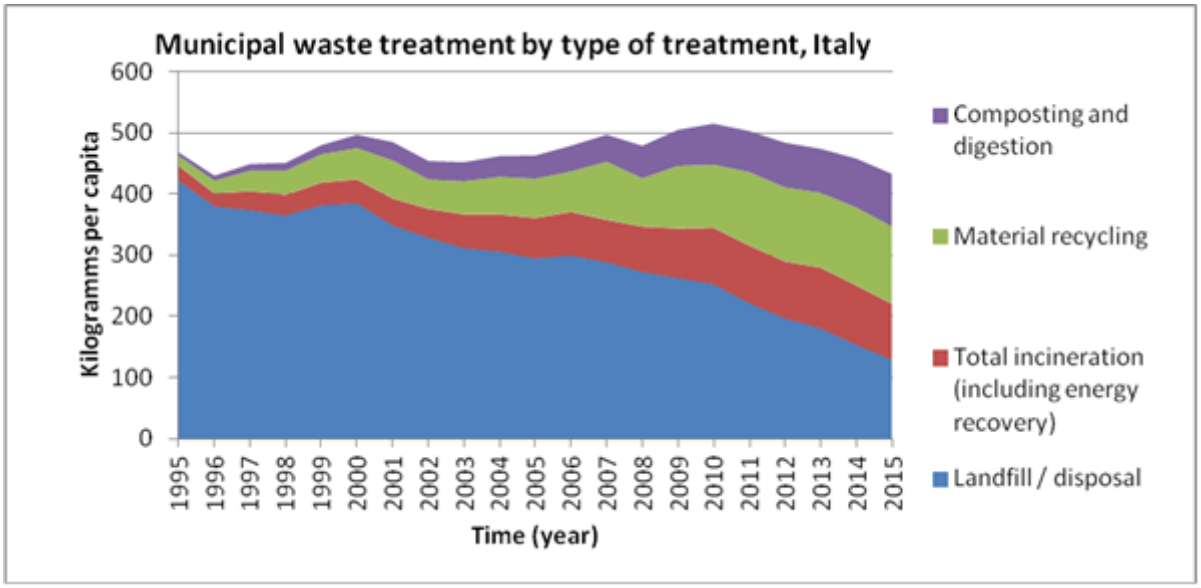


Fig.5.: Municipal Waste Treatment by Type of Treatment, Italy (figure prepared by author)

Waste management in Italy is managed at a municipal level in accordance with national legislation, and differs widely from area to area. Typically, rubbish is collected by a waste disposal company contracted to the municipal authority. Following garbage crises in the south of the country municipalities are increasing access to recycling services and domestic collection. While kerbside collection schemes with mandatory separation are more

established in the North, much of Southern Italy continues to rely on bottle banks and communal landfill containers.

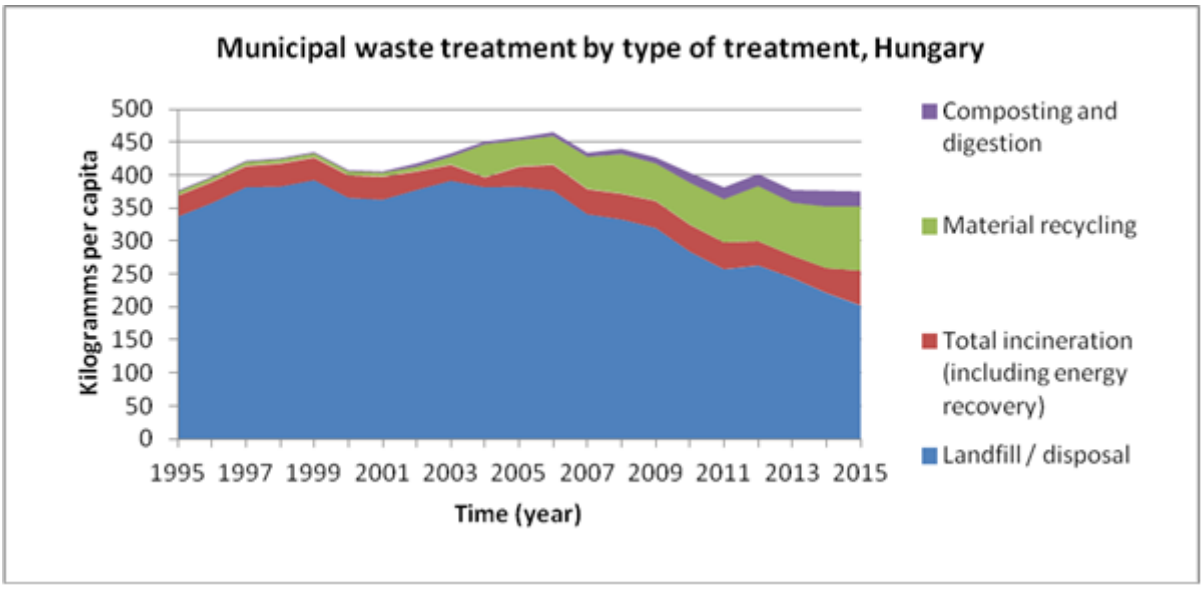


Fig.6.: Municipal Waste Treatment by Type of Treatment, Hungary(figure prepared by author)

Between the year 2000 and 2015, dozens of new MSW treatment facilities were built in Hungary to comply with the EU regulation on landfilling and recycling. As a result of the absence of nation-wide coordination, very different collection logistics and treatments options were chosen in each region.

Some of them concentrated on building sanitary landfills and tried to reach the target diversion rate by composting and material recovery. Others also use mechanical-biological treatments plants, reaching 30% landfilling compared to the produced waste amount. The cement industry and some power plants are the buyers of the residue derived fuels, leaving the MBT plants.

Only one incineration plant is in use in the country, in the Eastern part of Budapest, where MSW from mixed collection is burnt.

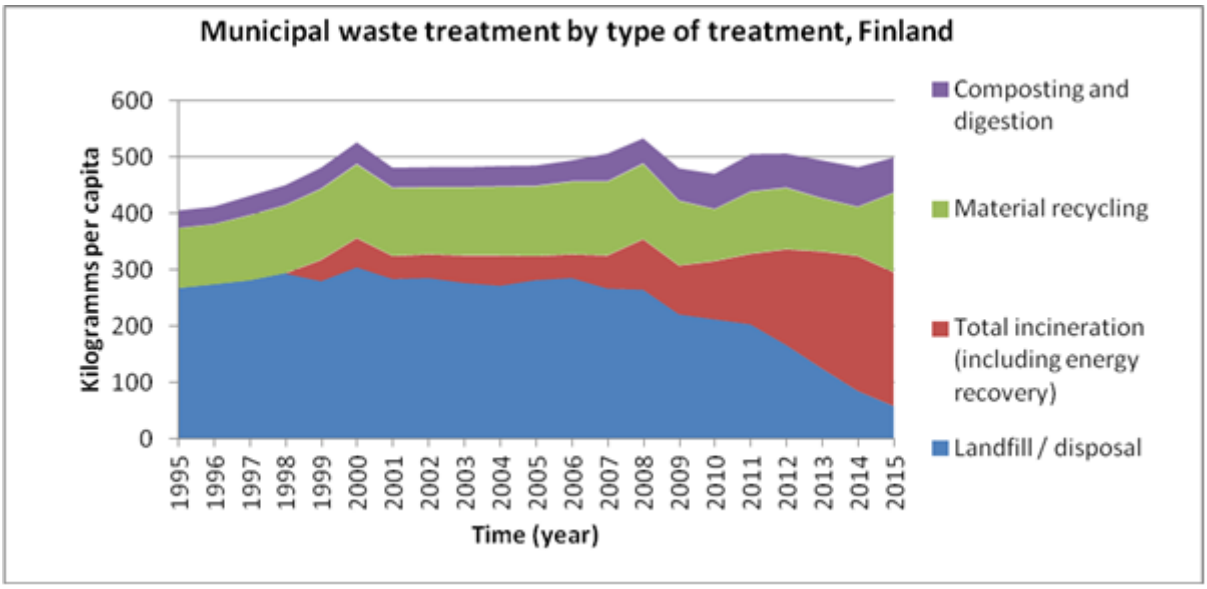


Fig.7.: Municipal Waste Treatment by Type of Treatment, Finnland (figure prepared by author)

In 2015, only one tenth of municipal waste was disposed in landfills. Energy production and recycling have competed for the recovery of landfill waste. Nearly one-half of all municipal waste is burnt in incineration and co-incineration plants. In recent years the growth has been strong especially for waste incineration. Over the past decade, the incineration capacity has grown six-fold. Mixed waste is turned into mere energy waste and separately collected waste into recycled material.

In 2015, Finland took a substantial stride towards top countries in recycling of separately collected municipal waste. The recycling quantities of electrical and electronic waste, glass and metal waste increased. The most influencing factor was, however, the specification of the quantity and recycling of fiber packaging waste generated in the field of trade. Nearly 90 per cent of municipal waste was recovered in year 2015, so in this area the circular economy is coming to an end.

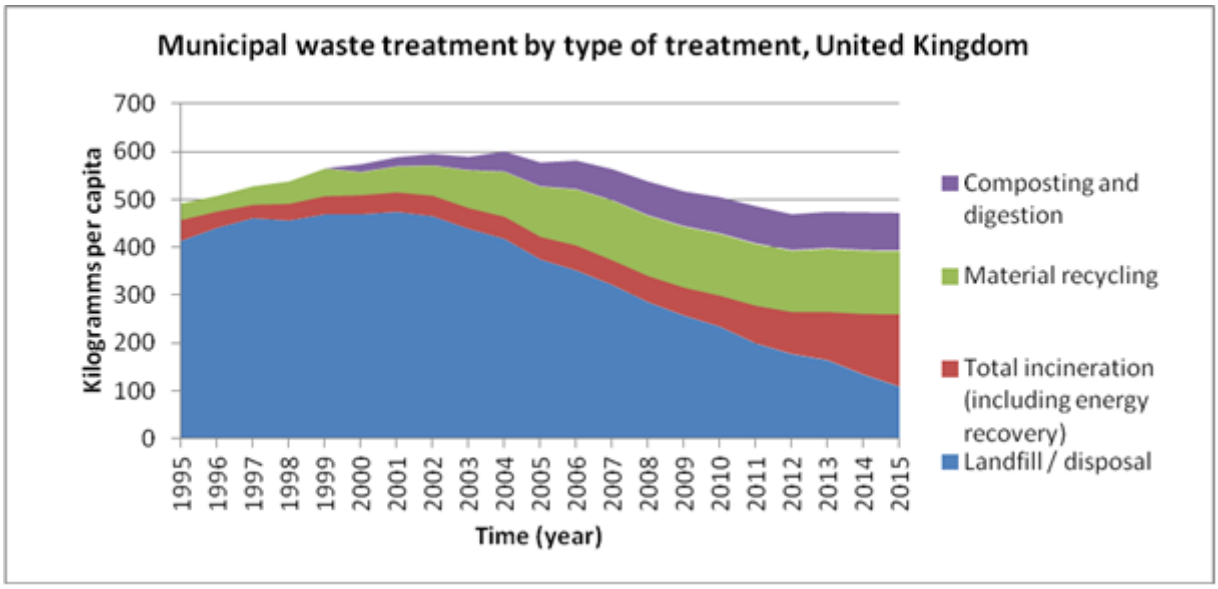


Fig.8.: Municipal Waste Treatment by Type of Treatment, UK (figure prepared by author)

Recycling/reuse together with composting have become the dominant methods of waste management in the UK, accounting for 42.2% of the total MSW. In 2012 a total of 13.1 million tonnes of MSW was recycled or composted in the UK, representing an increase of 27.3% since 2002. The per capita recycling and composting for UK residents is 0.21 tonnes. England recycles and composts the least with 0.20 tonnes per capita (42% of the total MSW produced in England) , followed by Northern Ireland (0.21; 39% of the total MSW produced in N. Ireland), Wales and Scotland (0.25 each; 50.1% and 42% of the total MSW produced in each country accordingly). According to the Anaerobic Digestion & Biogas Association (ADBA) there are currently well over 100 operational anaerobic digesters, not counting those operating at water treatment facilities. In 2012, there were also 203 composting sites (149 open windrow, 41 in-vessel and 13 combined open windrow and in-vessel), the majority of which are located in the east of England (38), followed by the South East (35) and north west (27). In the same year, there were 2341 recycling facilities operating, 749 of which processed end-of-life vehicles (ELV), 761 were vehicle dismantling facilities, 60 vehicle de-pollution sites and 771 metal recycling plants.

Landfilling of MSW decreased dramatically in the last 15 years: between 2000 and 2015, landfilled MSW decreased to almost 1/3 on the EU-27 level. Considering the 4 countries shown above, those countries achieved the most impressive reduction in landfilling where appropriate incineration capacity has been developed, namely Finland, UK, and Italy at some extent. Incineration seems to be a very efficient way to avoid landfilling, but it is certainly not in line with the circular economy concept.

Although landfilling rate shows a steady decrease year by year in the EU-27, these countries don't follow this linearity: Hungary and Finland produced major decrease after 2007-2008, the same happened to Italy and the UK but 7-8 years earlier. [18]

1.1.5. Needs of the European Industry

Three main indicators must always be kept in mind while talking about raw materials (RMs): supply risks, economic importance and environmental reliability. Critical raw materials (CRMs) are fundamental because of:

- Their close link to industry: non-energy RMs are linked to all industries across all supply chain stages.
- Development of modern technologies: the technological progress and the improvement of life quality are reliant on access to a growing number of raw materials. E.g. a Smartphone might contain up to 50 different metals, all of which help to give its light weight and user-friendly small size.
- Changes in environment/policy: the environment preservation is closely linked to RM exploitation. Indeed, RMs are irreplaceable in solar panels, wind turbines, electric vehicles, and energy efficient lighting. [19]

The Commission carried out a criticality assessment at EU level on a wide range of RM (in 2010: 41 RM were assessed, in 2013: 54 RM were assessed). The indicators are shown in Fig. 9:

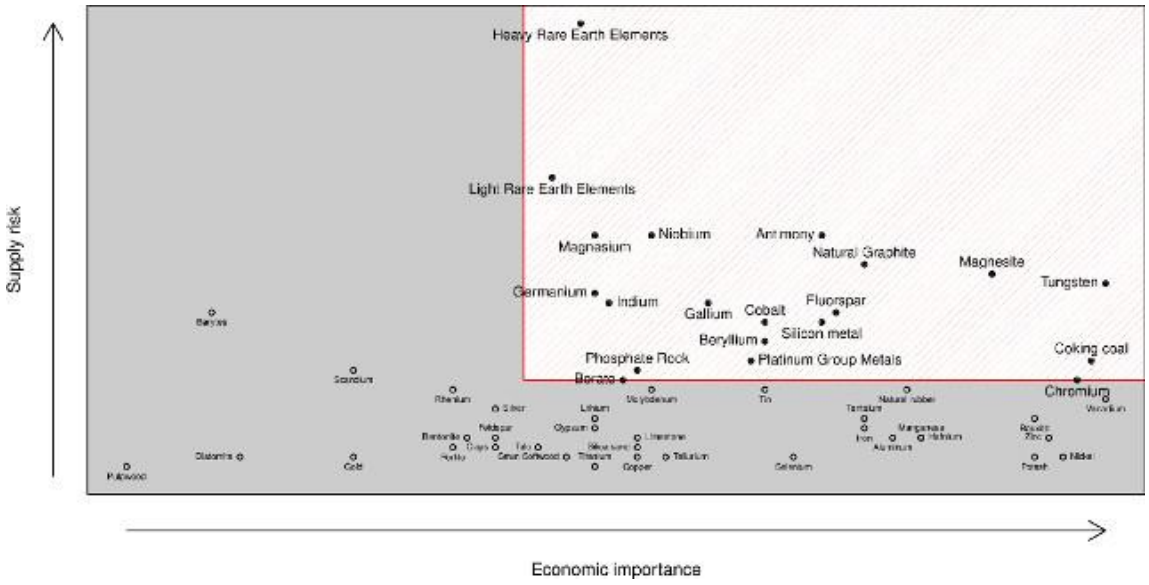


Figure 9: Distribution of RM in the Supply Risk/Economic Importance Graphic

- Economic importance: the proportion of each material associated with industrial mega sectors such as construction, combined with its gross value added to EU GDP. This total is scaled according to total EU GDP to define the overall economic importance of a material.
- Supply risk: the World Governance Indicator (WGI) is used to measure the supply risks of RM. This indicator takes into account accountability, political stability and absence of violence, government effectiveness, regulatory quality, and rule of law.

RMs are essential for the sustainable functioning of modern societies; they are used in several emerging technologies, and are highly employed in the electronic industry, such as capacitors, computer electronic device, etc.

Basic RMs like fuels, metals and wood are all important for life and prosperity. Presently, Europe is mainly dependent on the imports of major RM, which have been always affected by fluctuating policies of the market (European Commission 2011). Sectors like construction, chemicals, automotive, aerospace, machinery that provide a total value of € 1.324 billion and employment opportunities for more than 30 million people, are all dependent on availability of RMs. There is still a high potential for RMs available in Europe, but their exploration and extraction have faced a strong competition due to highly regulated environment and different land uses.

In general, RM availability is increasingly under pressure. The localization of the main world producers of CRM and Industrial Minerals (IM) evidences that European Union imports most of CRM and IM from other countries (principally BRICS countries, and China above all).

China is the biggest producer of the 20 CRM for EU. Several other countries have dominant supplies of specific RM, such as the USA (beryllium) and Brazil (niobium). EU primary supply across all candidate materials is estimated at around 9%. In the case of CRM, supplies from EU sources are even more limited. The demand for all the CRM is predicted to grow, with niobium, gallium and heavy rare earth elements forecasted to have the strongest rates of demand growth, exceeding 8% per year for the rest of the decade.

The needs of the European industry concern not only the CRM but an extremely wide range of RM, including metals and industrial minerals. For example, metals like zinc and nickel were and still are crucial for the EU economy, together with some metals that can be associated to them (e.g. PGE to Ni; Cd, Ge, Ga, In to Zn), whose importance has increased over the last decades. At the same time, industrial minerals of wide consumption like, for instance, feldspar and quartz, are fundamental for the ceramics and glass industry. Other RM, only apparently of lower value, are aggregates, very important for the European Industry because of their wide application fields (construction, buildings, filling material, etc…). [13]

1.1.6. Circular economy in the EU

The so-called circular economy has become the key conceptual basis for a number of EU policies. In the past, production has followed a largely linear economy model of take, make and dispose (Figure 10).

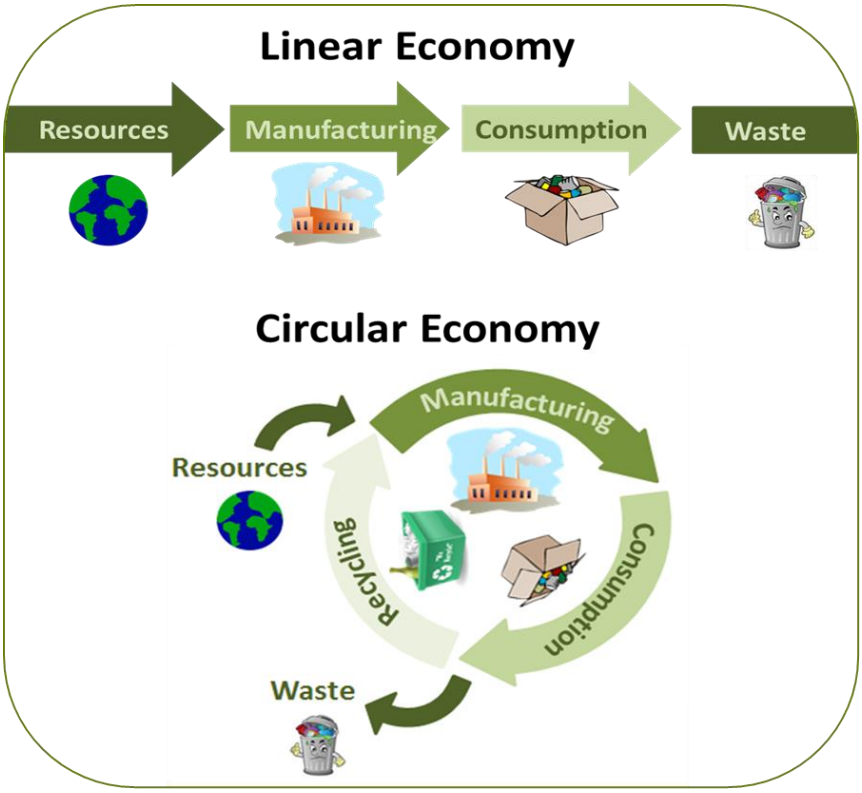


Fig. 10: Linear economy versus Circular economy

However, this has resulted in an abundance of waste and the depletion of finite, raw resources including critical raw materials (CRMs) and secondary raw materials (SRMs), putting manufacturing and industrial activities across the EU at risk.

The circular economy replaces this model with one in which resources circulate within the economy at a high value. Products, into which raw materials and energy have been invested, are recycled and reused. This reduces both the production of and the need for finite, raw resources.

In order to achieve a circular economy within waste management practices, life cycle thinking must occur (Figure 11.). This can be achieved by eliminating the production of waste and promoting reuse and recycling.

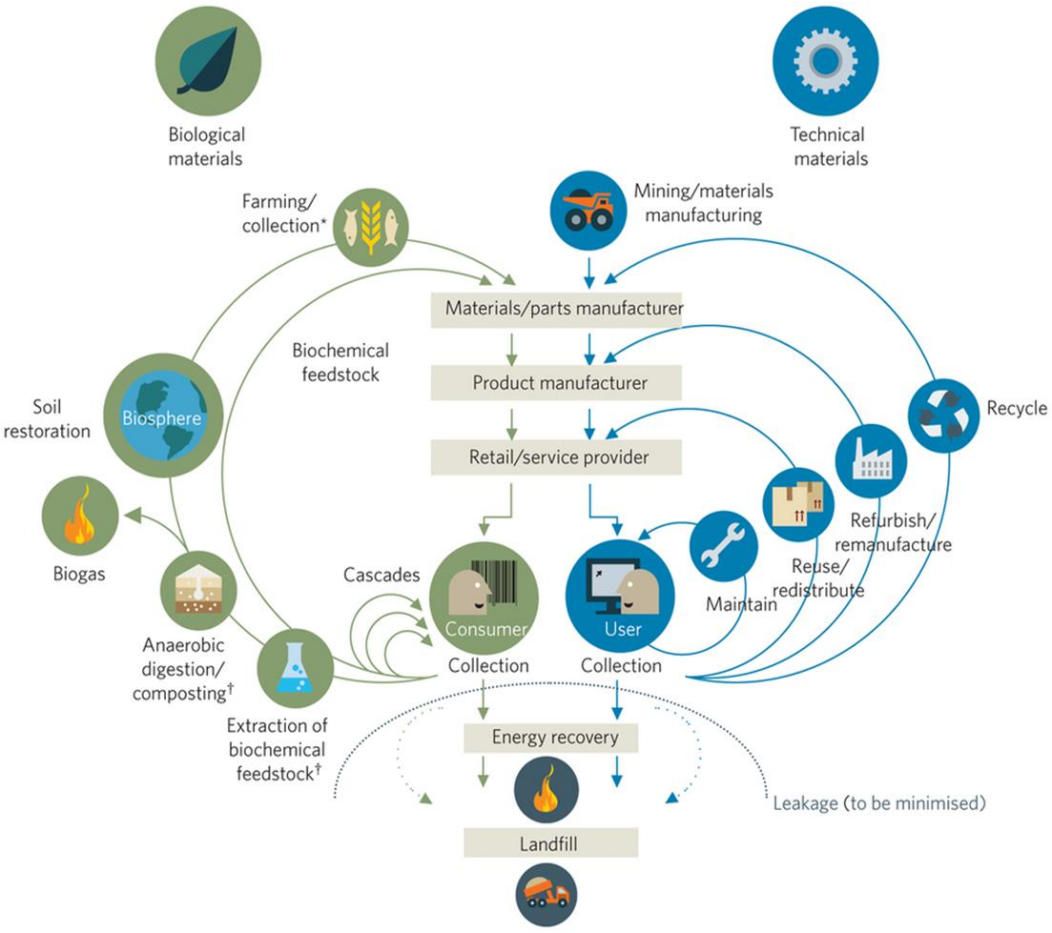


Fig. 11: Circular economy—an industrial system

(Source: www.ellenmacarthurfoundation.org/circular-economy/interactive-diagram)

1.2. Hungarian waste management plans and strategies

Planning levels:

1. Concept of Municipal Solid Waste Development (14 years)
2. National Waste Management Plan and National Prevention Programme (7 years)
3. Regional Waste Management Plans and Regional Prevention Programmes (6 years)
4. Public Waste Collector Waste Management Plan (3 years)
5. National Collection and Recovery Plan (3 years)
6. National Public Waste Management Plan (1 year)

1.2.1. Development Concept of National Municipal Solid Waste Management

Based on the current situation of waste management and particularly of MSW management in Hungary we can determine that the degree and depth of change required is so great that can only be realised in two subsequent development stages. In line with this, the responsibilities associated with waste management were defined at the highest level for the 14 year period between 2014-2027 in the Waste Management Development Concept (hereinafter "WMDC"). The basic objective of the WMDC is to define the main direction of developments for the 2014-2027 period and the associated resources that are available, based on the needs of domestic MSW management and European Union obligations. The main objectives of MSW management, in line with European Union obligations and domestic regulations are the following:

Lead Objective No. 1: Strengthening of community roles in the field of waste management

- Improvement of legal and organisational background required for the development, management and control of waste management

Lead Objective No. 2: Progress in the prevention of waste generation

- Elaboration and realisation of developments aimed at preventing the generation of waste
- Promotion of the matter of reuse

Lead Objective No. 3: Complex improvement of waste recovery

- In the area of waste treatment, taking recovery forward and, in connection with this, promotion of modern, environmentally friendly, sustainable waste treatment technologies conforming to EU norms
- Improvement of an up to date public municipal solid waste treatment system

Lead Objective No. 4: Finalisation of landfill systems

- Completion of programme to close and redevelop outdated landfills

Accordingly the WMDC specifies the following development objectives and schedule:

No.	System element	Timely development tasks 2014-2020 period	Timely development tasks 2021-2027 period
1.	Subsystem for prevention of waste-generation	Elaborate overall and detailed plan Intensive system development	Completion of developments started in previous period
2.	Waste collection and transport subsystem	Elaborate detailed plan Intensive system development	Completion of developments started in previous period
3.	Material recovery subsystem	Elaborate detailed plan Intensive system development	Completion of developments started in previous period
4.	Thermal recovery subsystem	Elaborate overall and detailed plan Preparation of system development	Intensive system development
5.	Landfill subsystem	Completion of developments started in previous period	None

All lower level planning tasks are specified in conformity with these objectives and schedule. Development areas affected by the concept:

- development of organisational structure ensuring the supervision, control and development of waste management
- infrastructure for prevention of waste-generation,
- mandatory tasks related to MSW,
- material and thermal recovery of waste generated as MSW, CDW or within another public service. [16]

1.2.2. National Waste Management Plan 2014-2020. (Government Decision 2055/2013 (XII. 31.) on the National Waste Management Plan)

Directive 2008/98/EC of the European Parliament and of the Council on waste (the "Waste Framework Directive") requires the competent authorities of Member States to establish one or more waste management plans.

The National Waste Management Plan must be prepared for 7 years and reviewed after 4 years

Contents of the National Waste Management Plan:

- Professional policy ideas related to waste management
- Domestic legislative background of waste management,
- The current situation of treatment of a certain waste stream, specified by waste stream, deficiencies detected, objectives to be achieved and the tools and measures required for realisation thereof
- The background knowledge required for effective waste management, long term planning objectives

The basic pillar of domestic waste management developments is the **National Waste Management Plan** (hereinafter "NWMP") specifying the development tasks delegated to the European Union development cycle between 2014 and 2020. The NWMP elaborates the objectives and tasks defined in the Waste Management Development Concept (WMDC) for the 2014-2020 period.

Directive 2008/98/EC of the European Parliament and of the Council on waste and repealing certain Directives (hereinafter the "Waste Framework Directive") requires the competent authorities of Member States to establish one or more waste management plans. Those plans shall, alone or in combination, cover the entire geographical territory of the Member State concerned. Hungary complies with this requirement by preparing the NWMP.

The Waste Framework Directive lays down measures to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use.

The NWMP contains Hungary's professional policy ideas related to waste management. The NWMP presents the statutory background of Hungary's waste management, which is followed

by expanding on the current situation of treatment of a certain waste stream, specified by waste stream, deficiencies detected, determining objectives to be achieved and the tools and measures required for realisation thereof. All in all the National Waste Management Plan covers all significant waste streams and ensures the background knowledge required for effective waste management, long term planning objectives and the steps for their realisation.

The **National Prevention Programme** (hereinafter the NPP) forms part of the National Waste Management Plan, which contains the objectives on waste prevention and the measures to be implemented for their achievement. One of the main targets of the NPP is the decoupling of the connection between necessary economic growth based on needs and waste production. The overall aim of NPP is to introduce measures that:

- promote the separation of resource use and reasonable economic growth based on needs;
- reduce the use of materials and waste generation;
- contribute to the realisation of more efficient resource management;
- contribute to the lengthening of the life-cycle of products;
- promote the application of solutions that have the smallest possible impact on the environment during their life-cycle; and
- promote job creation.

The Action Plan of the NPP presents those areas in which Hungary needs to take steps for promoting the prevention of waste production and the most successful realisation thereof.

The Action Plan contains five measure packages regarding the areas of intervention that must be need to be prioritised in the 2014-2020 period:

- Prevention of construction and demolition waste production;
- Reuse;
- Green public procurement;
- Environmentally conscious production and company culture;
- Education, awareness.

The long term objectives of the NWMP are based on the pillars of the waste hierarchy system. In the future waste treatment emphasising environmental elements and the application of environmentally friendly, innovative technologies will enjoy priority and the use of hazardous materials will be reduced. Society will view waste as a resource. Thanks to the achievement

of the objectives defined by the NWMP, waste dumping will be reduced and in the future only waste that can be recovered will be deposited.

Considering all of the above, the overall objectives specified in the National Waste Management Plan are the following:

- increase recovery rates,
- reduction of waste production,
- development and improvement of separate collection,
- separation, repair and repeated use of recyclable components of products that have become waste¸[16]

Relationship between the Waste Management Development Concept, the National Waste Management Plan and the Development Subsidy Programme of the National Waste Management Directorate of the National Inspectorate for Environment and Nature

No.	Waste Management Development Concept	National Waste Management Plan
1.	**Lead Objective No. 1:** Strengthening of community roles in the field of waste management: - Improvement of legal and organisational background required for the development, management and control of waste management	**Lead Objective No. 3:** Development and improvement of separate collection
2.	**Lead Objective No. 2:** Progress in the prevention of waste-generation: - Elaboration and realisation of developments aimed at the prevention of waste-generation; - Promotion of the matter of reuse.	**Lead Objective No. 2:** Reduction of waste production **Lead Objective No. 4**: Separation, repair and repeated use of recyclable components of products that have become waste
3.	**Lead Objective No. 3:** Complex improvement of waste recovery: - In the area of waste treatment, taking recovery forward and, in connection with this, promotion of modern, environmentally friendly, sustainable waste treatment technologies conforming to EU norms;	**Lead Objective No. 1:** Increase recovery rates

	- Improvement of an up-to-date public municipal solid waste treatment system.	
4.	**Lead Objective No. 4**: Finalisation of landfill systems: - Completion of programme to close and redevelop outdated landfills	

[16]

1.2.3. Regional Waste Management Plans and Regional Prevention Programmes

The regional waste management plans and the regional prevention programmes must be prepared for the territorial responsibility of the environmental authorities based on Government Decree No. 310/2013 (VIII.16.).

Regional Waste Management Plans shall include:

- the types, quantities and origins of recyclable or disposable wastes;
- the basic technical requirements related to waste treatment;
- special measures applicable to the various types of waste;
- the treatment plants and facilities suitable for treatment of wastes and undertakings authorised to carry out treatment;
- waste management objectives to be achieved;
- the action plan serving the achievement or realisation of the designated objectives:
    - definition of the measures promoting the rationalisation of waste treatment,
    - the order and deadline for their execution,
    - definition of the means, procedures and facilities required for their realisation and an estimate of related costs.

The objectives and tasks aimed at prevention of waste production should be set so as to ensure achievement of the following results:

- reduction of costs to the environment;
- reduction of use of primary resources and energy;
- reduction of the hazardous material content of wastes;
- reduction of per capita waste production in respect of specific waste streams;
- more widespread use of by-products and secondary raw materials;

- sustainable management of natural resources;
- application of low-waste production technologies and alternative technologies and use of substitute input raw materials;
- increase the life-cycle of products;
- reduction of consumption and encouragement of the development of sustainable consumption habits.

An action plan must be developed at minimum for instituting the following measures:

- a) promotion of practical implementation of producer responsibility;
- b) restriction of the use of hazardous materials;
- c) reduction of the quantity of waste generated from a specific waste stream;
- d) infrastructure development within the sector and promotion of research and development in the field of products and technologies that result in the generation of cleaner and less waste;
- e) development of institutions;
- f) promotion of widespread appllication of Eco-Management and Audit Schemes (EMAS) and ISO 14001 environmental management systems;
- g) green public procurement;
- h) building and development of servicing and reuse centres;
- i) need for creation or amendment of legislation;
- j) inspection, consumer protection;
- k) education, raising of awareness.

The following are examples of incentives related to the measures:

- tax allowances,
- deposit,
- establishment of reuse centres,
- eco-label or other quality assurance system,
- opportunities for subsidies available for technology or product development.

We note that in spite of the requirements of the effective Decree, in the past 5 years no regional plans were established not only for the Pécs region but for not region in all of Hungary.

1.2.4. Public Waste Collector Waste Management Plan

The public service provider prepares the plan for 3 years, the contents of which are as follows pursuant to Government Decree 438/2012 (XII. 29.):

- encouragement of and raising awareness with regard to separated waste collection,
- detailed plan regarding a larger degree of collection and recovery of biodegradable waste,
- detailed plan regarding a larger degree of collection of hazardous waste generated in the household,
- detailed plan regarding the establishment and operation of the door-to-door waste collection system,
- opportunities for larger degrees of preparing waste for reuse and building reuse centres;
- detailed plan presenting an increase of the recovery rate belonging to the scope of the waste management public service;
- measures proposed for the reduction of organic materials in landfills

1.2.5. National Collection and Recovery Plan

The National Waste Management Directorate of the National Inspectorate for Environment and Nature prepares the National Collection and Recovery Plan pursuant to paragraph b) of Section 20 (1) of Act LXXXV of 2011 on Environmental Protection Product Charges. The plan needs to be compiled for defining the tasks related to tracking the quantity, collection, transport, preparation and recovery of wastes generated by products subject to product charge in Hungary for an entire calendar year, which clearly presents the quantities of waste collection and waste management that the Government is counting on for a certain year, as well as the development potential in the system beyond performance of the basic tasks.

National performance is based on the totality of services ordered by the Ministry of Agriculture, performance by business organisations choosing individual waste treatment and other independent performance.

The fiscal space of the organisation providing state waste management is determined by the budget appropriation.

As of 2017, the organisation providing state waste management is not required to finance the subsequent sorting of selective collection and packaging waste originating from municipal waste collected by public service waste management providers!

With the increase of areas covered by selective collection and the proliferation of door-to-door collection the quantity of collected **public packaging waste** showed a steady growth until the end of 2017, however, due to the changes introduced within the operation of the public service system, in 2018 the quantities to be recovered are expected to reach only the 2016 levels.

For **glass packaging wastes** consumer collection (catering industry, trade) can be further increased: a rise in the quantity affected by financing and the unit price increase as of 2017 also encourage this. Recovery further approximates the 60% target set in the EU Packaging Directive. At the same time, however, reaching it or reaching the new, higher targets expected to be set in the European Commission's Circular Economy Package, will require a significantly denser collection network than the existing one or an economic incentive even with the expansion of the mandatory commercial take-back obligations effective as of 1 January 2018.

For **wood packaging waste** the per unit subsidy gradually increased from HUF 6 / kg in 2013 to HUF 12/kg to promote material recovery against energy recovery (incineration). At the same time, a shift in attitude will also be required for achieving the 60% target by 2025, which is set in the EU Circular Economy Package: it will be necessary to significantly expand collection beyond pallets and collection in public service waste-yards must be ensured everywhere. [20]

1.2.6. National Waste Management Public Service Plan (NWMPSP)

Government Decree no. 68/2016 (III. 31.) provides the following on the NWMPSP:

- The current system of waste management public service;
- Definition of national objectives;
- Definition of conditions with regard to compliance of public service provider (projected for public service area);
- Measures and tasks required for performance of the contents of the NWMPSP;
- Results expected during the planning period and opportunities for further improvement of waste management public service. [21]

The Government revisited the National Waste Management Public Service Plan accepted for 2016 by Government Decision No. 1250/2016 (V.27.), as a result of which the documentation for 2017 was prepared. This document complies with the requirements of Government Decree 38/2012 (III. 12.) on Government Strategic Management. The NWMPSP presents the public service professional policy objectives for 2017 and the measures required for obtaining the specialised area objectives. These professional policy objectives are built into the amount of the service fee through the fee formula that determines the service fee which ensures the revenues of the public service provider. This is how the legislator provides incentives to public

service to achieve the objectives. Such included professional policy objectives are for example the return rate targets set by the Waste Framework Directive for 2020.

The plan for 2017 formulated the following principles with regard to the areas to be covered by public service providers, i.e. the collection districts:

- When establishing the collection and transport districts, considering the infrastructure and that close to one quarter of the country's population live in the 23 major towns, for management purposes the districts should be established around the existing waste management infrastructure.
- In terms of collection and transport, in the future, we need to consider fully separated waste collection both in terms of quantity and economically.
- One-phased waste collection and transport should be pursued, in which the transport distance within the collection district should not exceed 50 km. Where that is not viable, two-phased collection and transport logistics should be applied through a transfer station and covering a distance of no more than 120 km.
- In terms of treatment, considering the geographic location of existing treatment facilities, the "proximity principle" should be applied during future developments as well.
- There should be no break in the public service area covered by one public service provider and public service providers should not be forced to pass through each other's areas during collection and transport. This requires that a facility directly ensuring waste treatment after collection and transport be located within the given public service area.
- When establishing public service districts, districts serving a minimum of 50,000 people should be established in view of the "proximity principle" and "economies of scale" and bearing in mind that the optimal public service area means a population of over 200,000.
- The public service district established should ensure the adequate servicing of the existing waste treatment facility - the system element operated by the public service provider - and the supply of the adequate quantities of waste required for efficient operation. [22]

1.3. Hungarian laws and regulations

1.3.1. Act LXXXV of 2012 on Waste

In 2008 the EU passed a new Waste Framework Directive (Directive 2008/98/EC), as a result of which Member States were required to reformulate the regulation of waste management. In order to implement the precautionary principle and the principle of preventive action a National Prevention Programme (NPP) must be established for a six year period by no later than the end of 2013. The NPP is e part of the National Waste Management Plan.

The requirements of the new Framework Directive were implemented in Hungary's waste management system essentially by the establishment of the new waste act. The legislators decided that considering the significant changes included in the directive and the experiences of the period that had elapsed since the creation of the first waste management act, rather than amending the existing law, they would create a new one. Finally, on 26 November 2012, Parliament passed Act CLXXXV of 2012 on Waste which entered into force on 1 January 2013, replacing Act XLIII of 2000 on Waste Management. The act introduced several new concepts and contains a large number of new elements. 44 implementation regulations have to be prepared in connection with the act.

New waste management principles were introduced, which include the following:

Principle of reuse and preparing for re-use: for the purpose of prevention of waste generation reuse, repair, recharge, and preparation for reuse of products shall be encouraged.

Principle of extended producer responsibility (instead of producer responsibility): the producer is responsible for selecting the appropriate products and technologies for meeting prevention and waste management requirements, for planning the recovery and disposal of waste generated from the product; based on extended producer responsibility the producer is also responsible for take-back and return of the product, for acceptance of waste originating from the product, as well as for performance of additional waste management activities specified in the law on product charge which also involve a financial responsibility.

Principle of recovery of biodegradable waste: the separate collection and recovery of biodegradable waste should be encouraged in order to return the cleanest possible material resulting from natural organic material circulation after recovery and to reduce the biodegradable content of municipal waste in landfills.

Principle of providing cost-effective waste management public service: waste management public service should be planned and developed such that the performance of the tasks should necessitate the smallest possible increase of the waste management public service fee.

Principle of prohibition of cross-financing: the public service fee should be established such as to cover the justified costs thereof and the reasonable profits of the public service provider related to this activity but it shall not contain the costs and expenditures of other business activities outside the scope of waste management public service.

A new element for producers is the obligation to establish reuse networks with the aim of repair and preparation for reuse of used products.

The "by-product" appears as a new concept which promotes recirculation of materials into the production circulation process. The by-product is generated during a process the primary aim of which is not the production of that product or material. Other conditions typical of the by-product are that further use thereof is certain, it can be used directly, the substance or object is produced as an integral part of a production process, it will not lead to overall adverse environmental or human health impacts, further use is lawful, i.e. it fulfils all relevant statutory requirements.

Another new factor is that those wastes which are suitable for direct use in a certain production technology after processing should be removed from waste status after obtaining this status.

The act considers the realisation and improvement of selective waste collection as a priority. By 2015 separated waste collection systems had to be implemented everywhere throughout the country and by 2020 the preparation for reuse and recycling of glass, metal, plastic and paper wastes must be increased to 50%. Selective collection is realised in municipalities primarily through the door-to-door system, use of waste collection islands is only justified according to the act in densely populated areas.

A new organisation was given an important role in the management of waste treatment tasks: the National Waste Management Agency Public Purpose Nonprofit Limited Liability Company (=NWMA). The NWMA was responsible for tracking, and as of 2012, had the exclusive right to coordinate waste management in Hungary. Through its activities it fills an important role in prevention of waste generation and in the recovery of selectively collected wastes. The NWMA was 100% state-owned, a company supervised by the Minister for Environment.

The tasks of the NWMA included:

- inspection of waste management processes
- coordination and inspection of tasks (collection, recovery, development) related to wastes generated from products subject to product charge
- participation in the establishment and development of environmental awareness in the population
- preparation and implementation of the National Collection and Recovery Plan [16]

The regulation also reorganises waste treatment public service: as of 2013 only undertakings owned by the state or local governments are authorised to perform waste treatment public service (see Act CXXV of 2013), thereby ending earlier market competition. [23]

Pursuant to the act, as of 2013 the operators of landfills are subject to payment of a waste landfill charge, which is determined based on the quantity and type of waste, whose rate increases gradually from 2013 to 2016. This encourages public service providers to give priority to selective collection rather than landfills. The amounts earned from the fee must be used for financing waste management duties. A similar waste disposal fee was introduced earlier in the Czech Republic, Slovakia and Poland. [24]

1.3.2. Act LXXXV of 2011 on Environmental Tax on Products

The obligation to pay environmental tax on products is an important economic regulation system. It affects products the use of which poses a direct threat to the environment or from which the largest quantities or highest hazard level of waste are generated. The first product tax act was Act LVI of 1995. According to the law, the entity subject to payment of the product charge either pays the tax imposed or if it agrees to pay the costs of recovery, it shall be exempt from paying the tax or be granted an allowance. Naturally this is only a good incentive if the latter is lower. Conditions for introducing the product tax: significant costs to the environment, homogeneous product, existence of substitute product. Its rate depends on the costs of waste treatment (including maintenance of the information, control and administrative system).

Application of the product tax system partially confirmed the hopes associated with it: waste treatment output gradually increased, the waste industry developed, public selective waste collection improved significantly and the budget earned a non-negligible sum of HUF 20-25 billion each year. In addition to this, however, due to constant changes, the product tax regulation became complicated and was also accompanied by major administrative burdens and in the meantime the list of products subject to the product tax also had to be reviewed.

The main reasons hindering operation of the system are summarised below (Ministry for Environment and Water, 2009):

- the regulation does not grant adequate incentive for achieving the waste management objectives (reduction a waste, increase of recovery
- as a result the amount of deposited waste increases/does not decrease, the amount of illegally dumped waste grows
- recovery rates achieved can be increased by improving public selective collection
- those who achieve community objectives (public selective collection, awareness raising) lose out on competition

- the range of those liable to pay is too wide and this greatly aggravates control (the number of those evading the system is large)
- administration is complicated
- the funds earned from product charges gradually melted into the budget and only served the original objectives of the act to a minor extent

Expectations from the new regulation: it should be simpler and more transparent and should emphasise that the product tax needs to be spent on raising waste management efficiency. Additionally, the new product tax act must be consistent with the Waste Management Act and the 2nd National Waste Management Plan (2009-2014).

The scope of Act LXXXV of 2011 on Environmental Tax on Products covers products subject to the product tax and related activities.

The aim of the creation of the Tax on Products Act is to collect necessary financial resources to prevent and/or repair direct and indirect environmental damage generated during the life-cycle of a product as well as to promote fulfilment of expectations set by European Union and Hungarian waste management regulation. To this end the act urges the largest possible increase of the waste recovery rate and promotion of reusable products.

Products subject to product charge pursuant to the Act are:

- batteries
- packaging materials
- other petroleum products
- electric and electronic equipment
- rubber tyres
- advertising paper [25]

The provision whereby no product tax needs to be paid for domestically produced reusable packaging if it is actually reused in a deposit system encourages the increase of reuse. This applies to reusable packaging from abroad if it is returned abroad within one year.

The definition of advertising paper was specified and includes the following categories: the various editions of periodic papers, leaflets and other handouts with text, publications containing graphics, drawings or photos, as well as maps. However, publications whose contents consist less than 1/3 of economic advertisements doe not belong in this category.

The amount of the product tax is based on the weight of the product. Essentially no product is exempt from the product tax, but the amount paid can be reclaimed under various titles (e.g. certified transport abroad, foreign sales).

Compared with the earlier product tax (valid until 31 December 2011), the amounts payable have decreased in most categories (rubber tyres, batteries, electric and electronic equipment, commercial packaging), however, the product tax payable on other petroleum products,

advertising paper and non-commercial packaging has grown. Annex 2 of the Act contains the actual amounts of the product tax payable.

The modified amount of the product tax has placed the printing industry at a significant disadvantage as the product tax payable on advertising paper has almost doubled and the tax needs to be paid by the press itself and not the client ordering the publication. The product tax payable on plastic shopping bags continues to be the highest, most probably to reduce or maintain the flow of shopping bags from hypermarkets. [26]

Individual waste treatment as the enforcement of the principle of producer's responsibility appeared as a new possibility in the Act. Collection from the end-consumer can take place at the site of the obligor or, together with the commercial unit distributing the product - at the sale location. The obligor must recover or arrange for recovery of collected waste. In this case the amount of the product tax is modified or decreased. Originally the possibility for individual waste treatment applied to wastes generated by the product and material stream of batteries, packaging, electric and electronic equipment and rubber tyres, then, after amendment of the implementation decree it also applied to other petroleum products (used or waste lubricants) but not to advertising paper. The recovery obligations can be fulfilled through the NWMA, which acts as an intermediary or individually. Waste management waste streams subject to product tax are managed by the NWMA and the Product Charge Committee. [27]

1.4 Croatian Waste Management Plans and Strategies

In Croatia, one of the most acute waste management problems is uninsulated, not specially engineered landfills, as about 1 million tons of the 3.5-3.7 million ton total annual municipal and production waste generated end up in such landfills that do not conform to EU standards.

As landfilling is dominant within the treatment of the 1.68 million tons (2016) of municipal waste (75-80%), the relevant strategies and plans are also aimed at reducing this number using a variety of means, in line with EU directives.

1.4.1. Waste Management Strategy of the Croatian Republic

The strategy, prepared in 2005, contains the following four basic chapters:

- assessment of current waste management systems;
- basic waste management objectives and measures;
- measures related to the treatment of hazardous waste;
- guidelines for waste recovery and landfilling.

The concept represented in the strategy is based on the following three coherent principles:

- **Avoiding waste-generation** which results in the maximum reduction of waste quantitiy and the minimisation of its harmful features at the place of waste-generation, thus the entire quantity of waste included in the later phases of waste management is lower and less harmful to the environment.
- **Recovery:** material recovery of waste that is unavoidably generated either as an energy carrier in view of technical opportunities, and environmental and economic factors; this phase begins with separate collection and transport to the place of utilisation of the useful and harmful components of waste.
- **Disposal** (landfill): placement of residual waste in appropriately arranged and controlled landfills (in existing but improved, as well as new waste landfills); this is the lowest ranked solution in the waste hierarchy; it also includes the restoration of waste landfills.

Based on the plan, Croatia's waste management vision for the future includes the following:

- gradual organisation of waste management centers with treatment plants, waste landfills and other facilities: An additional twenty county centers and four regional

centers outside of Zagreb with the gradual renovation and eventual closing of the majority of existing waste landfills,

- prohibition of landfilling on islands and installation of treatment stations with the separate collection, recovery and packing of residual waste, including transport to adequate inland centers,
- increased protection of underground waters in karstic areas in order to avoid infiltration of percolating water from landfills and other facilities,
- prevention of dumping in the sea, lakes, rivers and streams,
- hazardous waste treatment centers with adequate collection point network,
- keeping particularly important waste streams in check,
- high level participation of local industry in waste management projects, thereby contributing to lowering unemployment rates and reduction of foreign trade deficit,
- inclusion of foreign partners and capital based on independent feasibility studies, supporting of joint investments based on partnerships between the public and private sectors in line with IPPC and best available technologies (BAT),
- reinforcing existing waste management organisations and formation of interdepartmental waste management coordination bodies in respect of the various waste streams in order to facilitate cooperation between the ministries involved,
- educating the population, the professionals and the administrative organisations: programmes and activities aimed at increasing current knowledge levels, development and research as well as blending operative elements.

The quantified objectives of the strategy include reduction of waste deposited in landfills in Croatia to 58% by 2020, the separate collection of 18% of municipal waste, as well as the reduction of the organic fraction of municipal solid waste deposited in landfills to 55% of the 1995 level. [28]

According to the climate change report sent to the UN by Croatia in 2018, 26% of municipal waste was collected separately in 2016, which means that the original objective (set in 2005) was met in this respect. The numerical data on the organic fraction calls for caution as in the report mentioned, the annual quantity of the organic fraction of municipal solid waste is 1 million tons, whereas the entire quantity of municipal solid waste in that same report is 1.68 tons. If this were true, that would mean a 60% organic rate, which is unheard of in all of Europe. [29]

1.4.2. Croatian Waste Management Plan for the 2017-2022 Period

The waste management plan was conceived in the spirit of aiming for a circular economy, which promotes the development of the recycling industry and the creation of new, green workplaces. Naturally, the plan follows the waste management hierarchy accepted in the EU. The cornerstones of the newly developed system are the recycling centers, with units for sorting, composting and preparation for recovery of separately collected waste. 2 of these have been completed, 2 are in the preparation phase and 13 are being designed.



Map: planned regional waste treatment centres in Croatia

The plan outlines several priorities, primarily prevention and reuse, but it also emphasises the importance of door-to-door separate waste collection, sorting, composting and recovery. In addition, it accentuates research and development related to waste treatment and the closing and recultivation of landfills.

Compared with 2015 the plan defines the following objectives for 2022:

1. Development of municipal solid waste management
   - 1.1. Reduction of municipal solid waste generation by 5%
   - 1.2. Separate collection of 60 m/m% of municipal solid waste (mainly paper, glass, plastic, metal, organic waste, etc.)
   - 1.3. Separate collection of 40 m/m% of the organic fraction of municipal solid waste
   - 1.4. Reduction of the proportion of municipal solid waste disposal by landfilling to below 25 m/m%
2. Development of treatment of priority waste streams

2.1. Separate collection of 75 m/m% of construction and demolition waste
2.2. Establishment of sewage sludge treatment center
2.3. Development of packaging material waste treatment
2.4. Establishment of sea waste treatment system
2.5. Establishment of system for treatment of ships becoming waste and objects that sink to the seabed
2.6. Establishment of system for treatment of other special waste

3. Development of hazardous waste treatment
4. Recultivation of areas polluted with waste
5. Supplying of continuous training and information activity
6. Development of waste management information system
7. Development of controlling mechanisms for checking the waste management system
8. Development of administrative processes of the waste management system

Quantified objectives:

- Quantity of municipal solid waste < 1.57 million tons (1.1)
- Quantity of mixed collection municipal solid waste < 628.5 thousand tons (1.2)
- Quantity of separately collected municipal solid waste > 942.7 thousand tons (1.2)
- Quantity of separately collected paper, glass, plastic, etc. waste > 741.6 thousand tons (1.2)
- Quantity of separately collected bio-waste > 201.1 thousand tons (1.2)

The plan includes the following measures for achieving the objectives:

- Promotion of separate collection of paper, cardboard, glass, plastic and metal;
- Door-to-door separate collection;
- Providing incentives for collection methods depending on the quantity and quality of municipal solid waste;
- Introduction of tax levied on landfilling of municipal solid waste;
- Promotion of private and community composting;
- Construction of sorting plants;
- IT system assisting the inspection of waste streams;
- Training and information activities [30]

1.5 Croatian Act on Waste Management

The law passed in 2013 set forth the basic waste management principles, in line with the EU principles:

1. “polluter-pays principle” - the costs of waste management measures shall be borne by the producer of the waste or the earlier or current waste holder and it shall be financially liable for execution of measures taken for repairing of damage by rehabilitation;
2. “proximity principle” - waste should be treated at the appropriate facility that is closest to the place where it was generated, taking account of cost efficiency and environmental grounds;
3. “principle of self-sufficency" - waste should be treated self-sufficiently and the achievement of national level objectives should be enabled, taking account of geographic circumstances or the need for facilities specialised in special waste categories;
4. "traceability" – waste should be traceable to the product, the packaging and the manufacturer of the product, including the storage and handling of the waste.

In addition the act sets forth that the waste management costs shall be borne either by the producer of the waste itself or the producer of the product through which the waste was generated.

The law determines the waste management rank (confirming the EU hierarchy adopted in the strategy), as well as expectations in relation to the collection, transport and treatment of waste.

Commendably, the act does not only contain the principles of waste classification but also the conditions required for removal from waste status.

The act also requires that a national waste management plan be established, a part of which is the wast prevention plan.

The act sets the following dates for the three-step gradual reduction pf the proportion of the organic fraction deposited in landfills:

31.12.2013 75%
31.12.2016 50%
31.12.2020 35%

The biggest challenge in Croatia is the provision of the act which prohibits the depositing of waste in landfills that are not specially engineered and do not conform to the requirements. Considering that regional investment programmes will only be realised after several years, this

issue poses a serious challenge for waste management organisations. A similar statutory requirement was introduced in Hungary as well: The prohibition entered into force on 31.07.2009 and much to everyone's surprise it was enforced by the authorities. Closure of inadequate landfills led to a dramatic increase of waste deposited in landfills that were constructed in accordance with the regulations, which did generate extra revenues but shortened the lifespan of landfills.
In order to encourage recovery and discourage landfilling, the legislation introduced the concept of landfill tax.

The law regulates waste import and export, which follows the rules of Regulation (EC) No 1013/2006. [31]

2. Description of current waste management systems

2.1. Hungarian public service situation, in particular situation of the BIOKOM Group/Dél-Kom Ltd.

2.1.1. The situation and problems of the waste management public service system

2.1.1.1 Operation of the public service system until 2015

Treatment of wastes generated at the municipal population was the responsibility of local governments earlier as well. The local governments regulate this activity in local ordinances. 30 years ago, about 2,667 waste landfills that were not specially engineered operated throughout the country. The public service related to each of these was performed by a local government institution or company. Transport and placement of waste took place in an unregulated, disorganised, largely fragmented manner, thereby creating an environmental hazard.

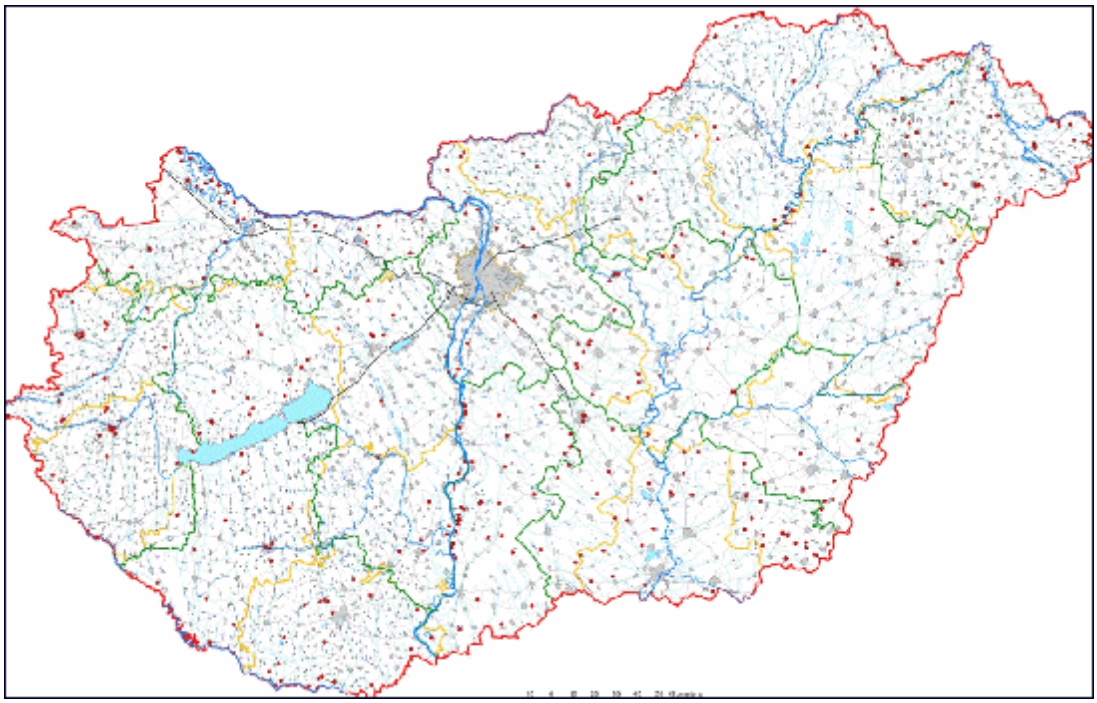


Fig. 12: 2002. Landfill survey: 2667 waste landfills in different conditions [3]

Due to the observation of, and compliance with the stricter rules, which led to a demand for expertise, infrastructure and capital, adequate performance of this task economically was only possible with the collaboration of several municipalities. In the period between 2000-2012, for profitability, cost effectiveness and business considerations, public service providers endeavoured to win public service in as many municipalities as possible and to build the required waste treatment infrastructure. Long term environmental objectives and the needs of the population were often neglected compared with short term economic interests. Service

area boundaries were often defined based on political considerations. The waste of certain municipalities – instead of the insulated waste landfill close to them– was deposited into uninsulated landfills that could be as far as 100 kms away just because that was a cheaper solution, even though it meant an environmental risk.

Following the turn of the millennium, the harmonisation of laws resulting from Hungary's accession to the European Union in 2004, environmental and waste-related legislation grew even stricter. Developments and waste treatment infrastructure conforming to EU requirements were realised within the framework of European Union subsidy programmes (ISPA, KA, KEOP). The local governments and in many cases the existing associations started the establishment of the model of the joint waste management system. They turned to the Managing Authority with recommendations and subsidy requests that included joint waste treatment infrastructure which they had worked out in detial. Artificial waste landfills (specially engineered), collection systems with collection island, waste sorting facilities and wasteyards were established. Thanks to the ever stricter statutory requirements, the number of waste landfills decreased from year to year. Selective collection appeared in an increasing number of municipalities. Waste management showed signs of development.

For environmental purposes, 2009 brought about progress in terms of the implementation of soil and water protection measures. After 19 June 2009 only those waste landfills were allowed to operate taht complied with the stringent requirements set forth in Ministry of Environment and Water Decree 20/2006 (IV.5.), which is based on Directive 99/31 (EU). Waste landfills without artificial insulation had to be closed down.

The establishment and operation of collection systems was not sufficiently motivated by the resource allocation method of the product charge system aimed at subsidising selective waste collection. The selective waste collection systems established from subsidies and operated by the public service providers constantly struggled with financial hardship.

Government measures taken in 2013 further aggravated the financial situation of public service activities with the introduction of the landfill charge payment obligation and by draining revenues through the central "utility price cut" measures. For the majority of companies, waste management public service activity became loss-making.

Collection systems - based on their performance to date - were unable to achieve outstanding performance in terms of return and recovery rates. According to a survey, Hungary ranked 23rd of the 35 examined (mostly European) OECD countries in terms of waste recovery.

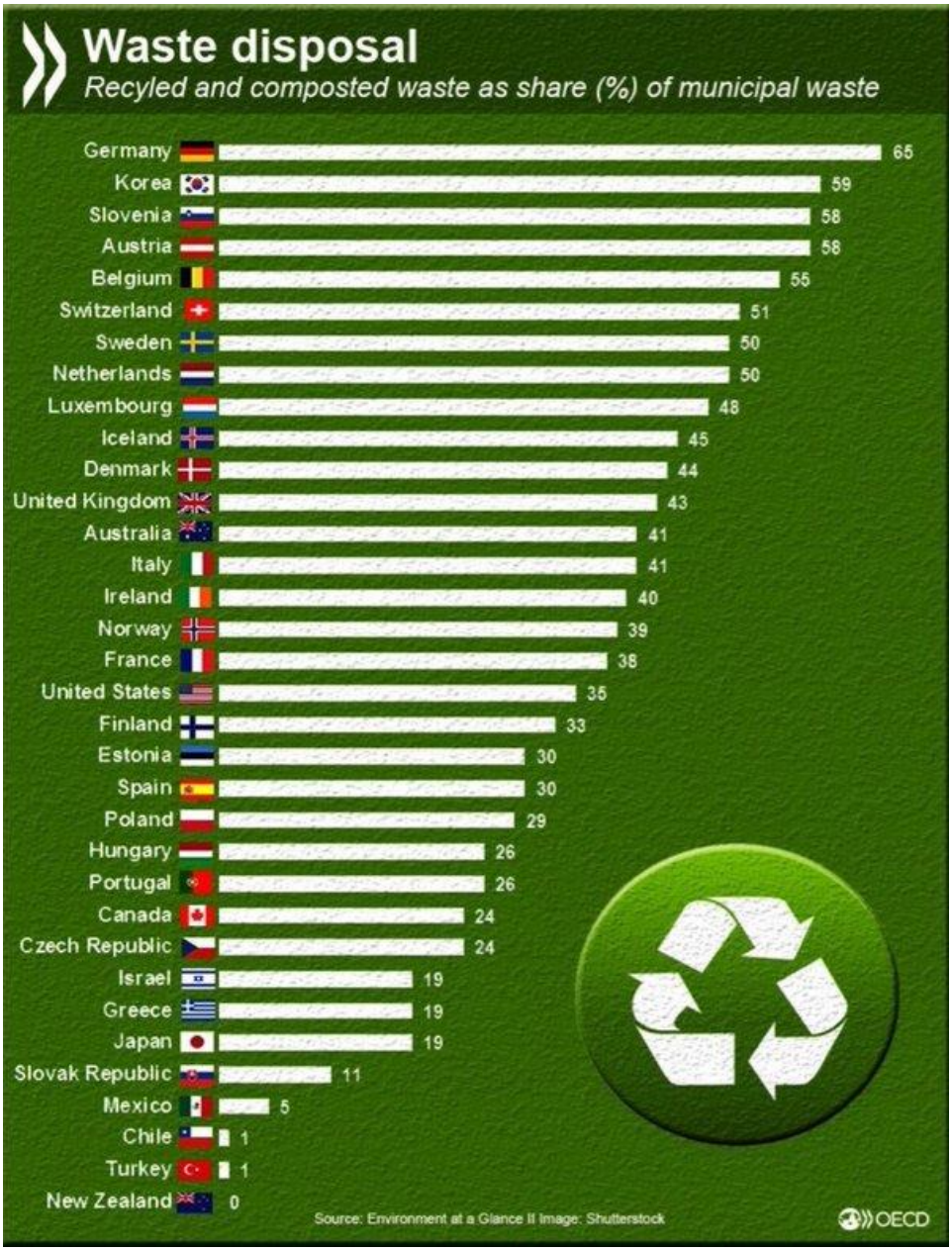


Figure 13: Recovery rates 2016[4]

2.1.1.2. Problems of the public service system operating in 2015

Major problems encountered during the operation of the waste management public service system in 2015:

- The waste management assets established within the last 15 years from EU funds are not evenly distributed, as a result they struggle with availability and efficiency problems due to unexploited capacities. It is difficult or impossible to operate facilities efficiently.
- The level of development of the large regions, the standard and content of waste management public service is extremely varied. Developments lack coordination in

several places. Parallel, unutilised capacities have been built in close geographic vicinity.

- The boundaries of the local government associations creating the large systems do not conform to the boundaries of the public service providers. Indentations and protrusions in the areas all cause problems in operation and in the performance of utilisation and replenishment obligations.
- Obligations arising from European Union subsidies are often not or only partially met. The vehicles and equipment obtained from EU funds are not included in any records and are often not even in use. The breaches of obligations carry significant financial risk.
- Public service fees are not uniform and were not determined in a uniform system. Within the area of one Association, the annual public service fee for one property ranges between HUF 5,000 and HUF 30,000 for the same public service content.
- Sustainable operation is jeopardised by the absence of provisions and amortisation coverage.
- Due to the high number of public service providers (173 on 01.01.2016 and 107 on 01.01.2017), the fragmentation of their operative area, uneconomical collection systems and uneconomical plant sizes are very common. Collection cannot be realised at minimum cost level if operated with routes that cross each other, that have protrusions and island units and with long-distance transport without load transfer. The below public service provider map illustrates these problems well.

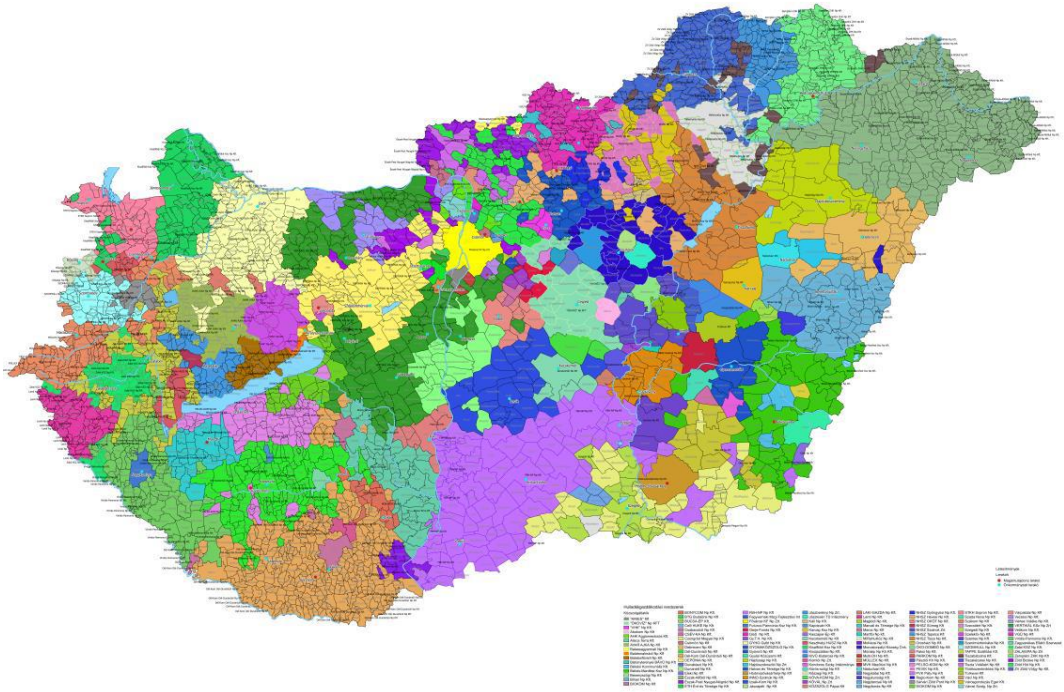


Fig. 14: Public service providers at the beginning of 2016 [5]

- The losses and overdue debts of public service providers accumulated from before 01 April 2016 have led to troubled financing and hence hamper development processes. In the absence of developments there is a risk that losses and overdue debts will be regenerated.
- Overdue debts are large and smaller companies struggle with inefficient debt collection.
- The data records and data supply of public service providers is not uniform and are often difficult to compare with each other. It is difficult to compile a realistic representation of the sector.
- The majority of public service providers are not sef-sufficient.

2.1.1.3. Changes in the regulation of the public service system

In order to change and solve the above-outlined situation, on 15 December 2015 Parliament passed Act CCXXI of 2015, which created the statutory conditions for the radical transformation of the system. The change points toward the creation of a public service system operating under government coordination and financing. In order to achieve the objectives, the Act ends the duality which existed to date thanks to the division of labour between the state and local governments and clearly delineates which waste management responsibilities are to be performed by the state and which tasks by local governments.

Local government tasks related to the organisation of waste management:

- specification of the detailed regulation of waste management public service at the local level;
- selection of the waste management public service provider;
- conclusion of the public service contract;
- provision of all data and information in connection with the public service contract which are necessary for exercise of the Coordinator Organisation's powers.

The state is responsible for creating Government Decrees to establish a framework for the operation of the Hungarian waste management system. Several government decrees regulate:

- waste management public service, selection of the public service provider, the data to be supplied by the public service provider, the waste management public service fee;
- generation, use, accounting and recording of a provision, environmental insurance and collateral by producers;
- payment of the waste landfill charge;
- registration and licensing of waste management activities, waste-related records and data supply obligations;
- preparation, territorial scope of waste management plans and prevention programmes, content elements of the plans;
- prevention and treatment of biodegradable waste generation and classification of compost produced from bio-waste;
- establishment and operation of the various waste management facilities;
- appointment of the Coordinator Organisation, its detailed tasks, coordination and resource management, data management and the data supply obligation of the public service provider, the municipal local government and the owner of the waste management facility.[2]

For the purpose of organising national level tasks the state established an institutional system acting under a new set of conditions and a new division of labour. On 01 April 2016 a new institution of government coordination, the National Waste Management Coordination and Asset Management Co. Plc. started operating. The service fee ensuring quarterly settlement of the public service activity performed by the public service providers and the institution of the opinion concerning compliance required by 01 October 2016, in line with the principles outlined in the National Waste Management Public Service Plan exercised a significant effect on the integration of public service providers. All of this will be presented in detail in chapter 3.

2.1.2. Catalysts of the integration process

2.1.2.1. Integration processes generated by market conditions in the earlier period

In past decades, lower intensity integration mechanisms operated in the establishment, organisation and development of public service systems.

2.1.2.1.1. Integration organisation at the level of public service providers

A few years ago waste treatment public service had to be provided under competitive market conditions. Market mechanisms had a significant effect on the players of the sector. Several companies – as proven right in the future – sought to gain a competitive advantage through growth and the establishment of a dynamically expanding system of companies. A widely applied practice was the creation of a public service company jointly held by the local government and privately or even a network of companies developing from these. The systems of companies thus created were characterised by a rational division of labour founded on professionalism. The division of labour among companies – which utilised the resources and capacities very efficiently in terms of geography and professionalism – ensured a significant competitive advantage. The BIOKOM company group built its market position in the South Dunantul region by applying this strategy. Cooperating with public service providers operating within its public service area and neighbouring areas, with the involvement of market players an integrated waste management system consisting of several public service providers was formed at the beginning of the 2000's. In public service areas that became strongly loss-making as a result of the statutory amendments in 2013 (see chapter 2.1.) the effect of the market organisation power turned around for a while. Some companies tried to improve their financial situation by transferring their loss-making areas.

2.1.2.1.2 Integration at the local government level

Organisation of waste treatment public service is a mandatory local government task. Under the tightening conditions the tasks requiring ever larger investments, even with the involvement of public service providers that were backed by private funding, justified the use of the largest possible scale of EU subsidies for developments, since the profit-oriented public service providers and public service systems sought development opportunities that would spare them some capital. In order to apply for the subsidies local government associations had to be created and large regional systems had to be planned. Propelled by the subsidies, an integrative process started at the local government level. Unfortunately in many cases these were organised based on political considerations. The area boundaries, the technical content of the completed infrastructure and the obligations arising from the subsidies generated professional and operational problems in subseque4nt operation.

2.1.2.2. Creation of the National Waste Management Coordination and Asset Management Closed Company Limited by Shares

Under market conditions enforcement of all state, local government and social interests, as well as achieving the environmental and efficiency objectives that were becoming more important on the long run proved difficult. The problems that arose pointed out the need for government coordination.

Based on previous years' experience it grew obvious that a central player able to perform coordination tasks at the national level was missing from the structure of the waste management institutional system to coordinate the current waste management market players and the execution of tasks arising from various EU and domestic obligations listed earlier, and in particular EU-subsidised projects, to harmonise development demands, create optimum economic (cost-effective) conditions both in terms of investment and operation costs.

The absence of such an organisation is all the more apparent because the waste problem affects the players of both the business and the public sectors alike and thereby appears as the inverse of all economic processes.[6]

In the case of public service coordination, due to centralised control and organisational concentration it is easier to carry out the rationalisation reform objectives, the integrations and realignments that would have been necessary in the last 20 years but met with significant local resistance. A more uniform, consistent and transparent output can be expected from the centralised and stricter regulation of services and organisations.[7]

Pursuant to Section 32/A of Act CLXXXV of 2012, in 2016, the state established a coordinator organisation to perform the state's waste management public duties by creating Government Decree 69/2016 (III.31). The Coordinator Organisation was registered by the Court of Registration in January 2016 by the name of **NHKV National Waste Management Coordination and Asset Management Closed Company Limited by Shares** (short name: NHKV Zrt.). The Coordinator Organisation was registered by the Court of Registration in January 2016.

The primary duty of NHKV Zrt. is to establish and develop the territorially optimised and uniformly standardised system of waste management public service in Hungary with the creation of a financing system that is sustainable on the long run at a break even level.

The objectives to be achieved by the Coordinator Organisation were determined in conformity with the government expectations:

- uniform, nonprofit, break even public service system, with the participation of the Coordinator Organisation, the local governments, the public service providers and the users of the service;
- maintaining the achievements of the utility price cuts;
- full performance of the recovery objectives set by the European Union;
- organisation and ensuring of territorially optimised public service, organisation of cooperation occurring within developments;
- by improving the security of supply, provision of a uniform, high standard service to the population, widespread expansion an efficient operation of a separated (selective) door-to-door waste collection system.

Duties of NHKV Zrt. as a Coordinator Organisation are the following[8]:

- determines the national objectives of waste management;
- determines the direction of waste management development;
- performs coordination between local governments and regions;
- prepares the National Waste Management Public Service Plan, which, among others, determines the optimal territorial boundaries of public service and the minimum public service duties to be performed in a given area;
- establishes whether the development of the waste management public service system element meets the National Waste Management Public Service Plan;
- establishes the system of optimal use of infrastructure resources in the interests of meeting the objectives and development endeavours of waste management at the national level;
- manages the assets entrusted to it voluntarily by local governments and local government associations;
- collects the public service fee and pay to the public service providers the service fee established by the Minister responsible for determining the waste management public service fee;
- manages the liabilities generated within the framework of public service.
- determines whether the activity of a certain public service provider conforms to the requirements specified in the NWMPSP and issues an opinion thereof (hereinafter the “conformity opinion”).

The conformity opinion is a powerful coercive instrument in the hands of the NHKV. The declaration of conformity of public service providers that did not get a public service role in the integration process was revoked. Examples for the reasons behind revocation are not meeting the recollection rates specified in the NWMPSP or non-compliance with collection frequency or failure to pre-process communal waste. This measure ends one of the basic

conditions of lawful operation within six months, as well as the right to secure financing of the activity, i.e. to earn the service fee.

2.1.3. Financing of the public service system

2.1.3.1. Financing of collection and pre-processing

After 01.04.2016 the public service provider was not entitled to issue an invoice to consumers and to collect the public service charge. The public service charge is collected by NHKV Zrt. The coordinator organisation pays a service fee to the public service provider from the incoming revenues to cover its justified costs. The detailed rules of the payment are laid down in the Decree 13/2016 (V.24.) NFM. [10]

The fee paid to the public service provider by the coordinator organisation based on the regular data supply of the former pursuant to the request of the coordinator organisation, calculated from the data supply, the quantity of waste management public service tasks and the quality of work processes performed, as amended by the correction factors. The legislation determines a standard fee which is the fee base established in a decree and which is due for the minimum public service content prescribed from the various public service areas in the National Waste Management Public Service Plan. The service fee is based on this standard fee. The standard fee can be corrected in a positive direction by not more than 70% or by 60% in a negative direction based on the correction factors stipulated in the decree. The corrected standard fee is the amount payable per unit for performance of the waste management public service, in accordance with the conditions stipulated in the NWMPSP.

Determination of the net service fee applicable to the service performed in a certain calendar quarter: the multiple of the corrected standard fee and the quantity of the quarterly service expressed in litres is decreased by the revenues generated at the public service provider from the sale of profit material. The service fee includes the amortisation linked to asset management. Lack of minimum reserves leads to sanctions and a withdrawal of fees.

2.1.3.1.1. The general formula for the service fee calculation is as follows [10]:

$$\left[\left(S + \sum_{i=1}^{9} K_{Poz,i} - \sum_{i=1}^{10} K_{Neg,i}\right) \text{x } N \text{ x } M\right] - \sum_{i=1}^{5} C_i$$

S: standard fee [HUF/litre]
KPoz,i: positive correction factor [HUF/litre]
KNeg,i negative correction factor [HUF/litre]
M: emptied quantity [litre*]
* The litre amount is determined in respect of a certain public service area based on the litre amount serving as the basis of the public service fee.
N: population density factor
Ci: lump sum deduction [HUF]

The general formula of negative and positive correction:

$$K_{X,i} = \sum_{j=1}^{n} A_{j,i} \text{ x } E_i \text{ x } L$$

Aj,i: The proportion derived from required pperformance
Ei: Value of correction [HUF/litre]

L: Population factor

The standard fee in 2016 and 2017 in all public service areas: HUF 2.737 / litre. This includes the collecting and transporting of mixed municipal waste at a required frequency prescribed by law, the collecting and transporting of green waste according to the minimum requirements of the NWMPSP, the collecting and transporting of selectively collected packaging waste according to the minimum requirements of the NWMPSP and the collection of bulky waste.

The standard fee provides cover for the operational costs of the equipment, machines, tools and facilities used for performance of the public service tasks described (including the costs of pre-processing performed in the interest of material recovery). It covers the disposal costs of pre-processed, unrecoverable residual waste, which includes the landfill charge, as well as

the costs of operation of customer service desks and representations. The costs arising from the performance of other tasks conforming to the NWMPSP that were included in the public service contract and local government decree in force on 1 April 2016 in respect of that public service area qualify as justified and refundable as are costs related to the maintenance, reconstruction, renovation, replacement or eventual development of the assets required for performance of the public service which are owned, managed or operated by the public service provider. It covers the justified costs of the closure, re cultivation, aftercare and monitoring of the waste management facility operated by the public service provider, affected by the performance of environmental obligations and waste management public services.

2.1.3.1.2. Positive correction factor

The Coordinator Organisation applies a positive correction factor if a certain public service duty included in the calculation of the standard fee is exceeded. The value of the specific positive correction can be defined in HUF/litre in respect of the individual property users based on the quality and quantity parameters of the public service system, with the amount of the correction factors included in following table.

No.	HUF/litre	Description of positive correction factor
1.	0.042	Provision of service above the minimally required by the NWMPSP in the collection of green waste.
2.	0.208	Agreeing to perform excess service above the minimally required by the NWMPSP in the collection of separated packaging waste.
3.	0.083	Provision of service at a higher standard than that minimally required by the NWMPSP in the collection of bulky waste.
4.	0.186	Pre-processing of collected and transported wastes is performed above the minimum technical, quantity and quality requirements set by the NWMPSP.
5.	0.755	Selection of the recyclable material fraction of municipal, mixed waste by mechanical, optical treatment for at least 20% of input waste.

6.	0.472	Performance of pre-processing for the purpose of energy recovery for direct recovery (until post-shredding) in the case of at least 30% of waste received for treatment.
7.	0.125	Biological stabilisation of mixed waste as a proportion of deposited waste.
8.	0.019	Recovery and production performed by the public service provider itself beyond the rates minimally required by the NWMPSP.
9.	0.2	Provision of collection bins (bags) free of charge to real property users for door-to-door collection of mixed waste.

Table x: Table containing a description of positive correction factors and the value of correction [10]

Upon review of the factors described in the above table we can establish that the larger positive correction rate can be achieved by an adequate level of selective collection, proper pre-processing of wastes, pre-processing done in the interest of energy recovery and by adequate separation of the mixed fraction in the interest of material recovery. Investment into extremely costly technology is required for achieving the excess performance levels. The establishment of such a system requires capital, larger quantity of waste to be processed, a larger service area, i.e. a larger number of households serviced. The larger companies were easier able to meet these criteria, while the smaller companies could not fulfill them or depended on the larger companies in their performance.

The positive correction factors of the fee formula place the larger companies at an advantage in terms of financing and further aggravate the position of smaller companies which due to their size operate with higher relative costs and lower efficiency anyway. With the reinforcement of larger companies arising from their financing situation and the deterioration of the situation of smaller companies arising from their lower revenues the integrative effect is strengthened.

2.1.3.1.3 Negative correction factor

Where the public service provider underperforms, the Coordinating body applies a negative correction. The value of the specific negative correction is defined in HUF/litre in respect of the individual property users based on the quality and quantity parameters of the public service system, pursuant to the following table:

No.	HUF/litre	Description of negative correction factor
1.	0.499	Mixed collection does not take place with the frequency specified by law.
2.	0.042	Inadequate performance of green waste collection
3.	0.208	Underperformance of the collection of packaging waste as compared with the minimum requirement specified in the NWMPSP.
4.	0.083	Underperformance of the collection of bulky waste as compared with the minimum requirement specified in the NWMPSP.
5.	0.001	90% of collection and transport is not performed in its own operation.
6.	0.186	Pre-processing of collected and transported wastes is not performed at the minimum technical, quantity and quality requirements set by the NWMPSP.
7.	0.001	90% of pre-processing is not performed in its own operation.
8.	0.001	90% of disposal is not performed in its own operation.
9.	0.465	Disposal or deposit in landfills of waste above the quantity defined in the NWMPSP
10.	0.026	Incomplete or inadequate customer service, percentage of non-performance.

Table y: Table containing a description of negative correction factors and the value of correction [10]

Upon review of the factors described in the table we can establish that the larger negative correction rate can be avoided by an adequately efficient selective packaging waste collection system, proper pre-processing of wastes, adequate diversion of waste from landfills, and pre-processing performed for the purpose of energy recovery. Investment into extremely capital-intensive technology is required for achieving the required performance levels. In terms of financing, the negative correction factors of the fee formula place the larger companies in a

better position, while the smaller companies are at a disadvantage, therefore these factors also strengthen the integrative effect.

2.1.3.1.4. Population factor

The population factor further enhances the effect of the positive and negative correction factors. The resident equivalent belonging to the public service area of the public service provider determines a multiplier number. The rate of the positive and negative factor also changes according to the rate of the multiplier.

The table below (Figure 3.3) shows us that the positive multiplier factors aid the larger public service providers more and the smaller ones less, and that negative multiplier factors encumber the larger companies less, while they place a greater burden on smaller companies.

No.	The aggregate population of the public service area covered by the public service provider [persons]*			Population factor (L) positive correction	Population factor (L) negative correction
1.	0	-	10,000	0.7	1.3
2.	10,001	-	25,000	0.8	1.2
3.	25,001	-	50,000	0.9	1.1
4.	50,001	-	75,000	1	1
5.	75,001	-	100,000	1.05	0.9
6.	100,001	-	125,000	1.1	0.9
7.	125,001	-	150,000	1.15	0.9
8.	150,001	-	175,000	1.2	0.9
9.	175,001	-	200,000	1.25	0.9
10.	200,001	-	300,000	1.3	0.8
11.	300,001	-	400,000	1.35	0.8
12.	400,001	-	500,000	1.4	0.8

13.	500,001	-	750,000	1.5	0.7
14.	750,001	-	1,500,000	1.6	0.7
15.	1,500,001	-		1.7	0.7

table z: table containing population factors [10]

The legislator's intention can be detected after evaluation of the factors. With the creation of the fee formula the catalysing of public service provider integration is obvious. Larger companies that operate higher level infrastructure and with a larger public service area are able to achieve higher revenues in spite of the fact that according to their higher relative cost indicators they are able to operate at lower costs.
The operation of minor companies becomes increasingly cumbersome and eventually impossible, with larger companies taking over their tasks. The process moves toward the integration of public service areas.

2.1.3.2. Supplementary financing

The duties of the National Waste Management Directorate of the National Inspectorate for Environment and Nature (OKTF NHI) are determined by Section 20 of Act LXXXV of 2011 on Environmental Protection Product Charges. The main duty of the OKTF NHI is to partially finance the collection and recovery of domestic wastes, in connection with which it also performs social awareness and industrial development tasks. The aim of the main duty is to ensure performance of European Union obligations, i.e. minimum recovery revels. The aim of the latter related tasks is to increase the recovery rate, as well as the complex development of the Hungarian waste management system with a value-generating approach. All of this with planning at the national level which considers the requirements of regionality and subsidiarity and which planning ensures that no unreasonably excessive capacities are established thereby also creating secure and reliable conditions of oeration in addition to a healthy competition. The financial cover for these tasks is created by the product charge revenues defined by the Act on Environmental Product Charges, the budget of which was HUF 63,389 million in 2015. In 2015, the Government approved HUF 12,747.2 million for the OKTF NHI to perform its waste management duties.

The essence of the financing model of OKTF NHI is that, considering the conditions defined in the Act on Environmental Product Charges wherein partial financing is a central element as

well as the social awareness raising explicitly defined in the Act on Environmental Product Charges (minimum 7% of costs). These two elements covered the sources ensured from the budget at the launch of the legal predecessor National Waste Management Agency Nonprofit Co. At the same time, based on the factual data of the activities carried out over the year, industrial development objectives are executed from the resources that remain as the residual value of the financing related to the above two tasks and the Government may grant funds for this purpose directly pursuant to Section 20(1) d) and h) of the Act on Environmental Product Charges. OKTF NHI provides partial financing on the one hand through direct contracts (in the case of public service providers where the public procurement procedure cannot be repeated because the public service provider won the activity through public procurement or an in-house contract) and on the other hand through public procurement procedures to market players. The former signifies about one third of service partial financing, while the latter constitutes about two-thirds. As the resources provided to the OKTF NHI are limited from above and cannot be exceeded, therefore, in the establishment of the contractual relationships within the framework of partial financing the acquired service quantities (e.g. the amount and value of collected PET bottles) were also limited from above. In the case of public service providers, it is possible to exceed the undertakings included in the contract and the OKTF NHI makes use of this, however, this is not a possibility in public procurement procedures. In the case of the latter, we cannot speak of this based on the rules of public procurement either, as there is no cover for excess performance in the planning phase. So therefore, in particular during the launch phase, a significant residual value is accumulated because market players are unable or unwilling to provide the requested services in a certain part of the public procurement procedures announced. Currently this residue forms the source of the industrial development tasks to be performed by the OKTF NHI. OKTF NHI spends the sum of resources thus available - with the approval of the Development Committee - for the realisation of the objectives determined by it, primarily via the subsidies provided by the directorate and secondarily based on necessity and expediency factors and in individual cases via public procurement procedures. OKTF NHI provides the funds within a financial framework and defines the contents of public procurement procedures and the funds granted for them on an individual basis. In order promote the entry into the market of the subsidies the OKTF NHI created the Development Subsidy Programme (hereinafter the OKTF-NHI-FPR).

The development objectives established in the OKTF NHI-FPR and the NWMP form a single unit thereby ensuring that the development objectives targeted by the OKTF NHI meet the expectations of the NWMP and, accordingly the WMDC. [16]

2.1.4. Major factors in the establishment of optimum public service regions

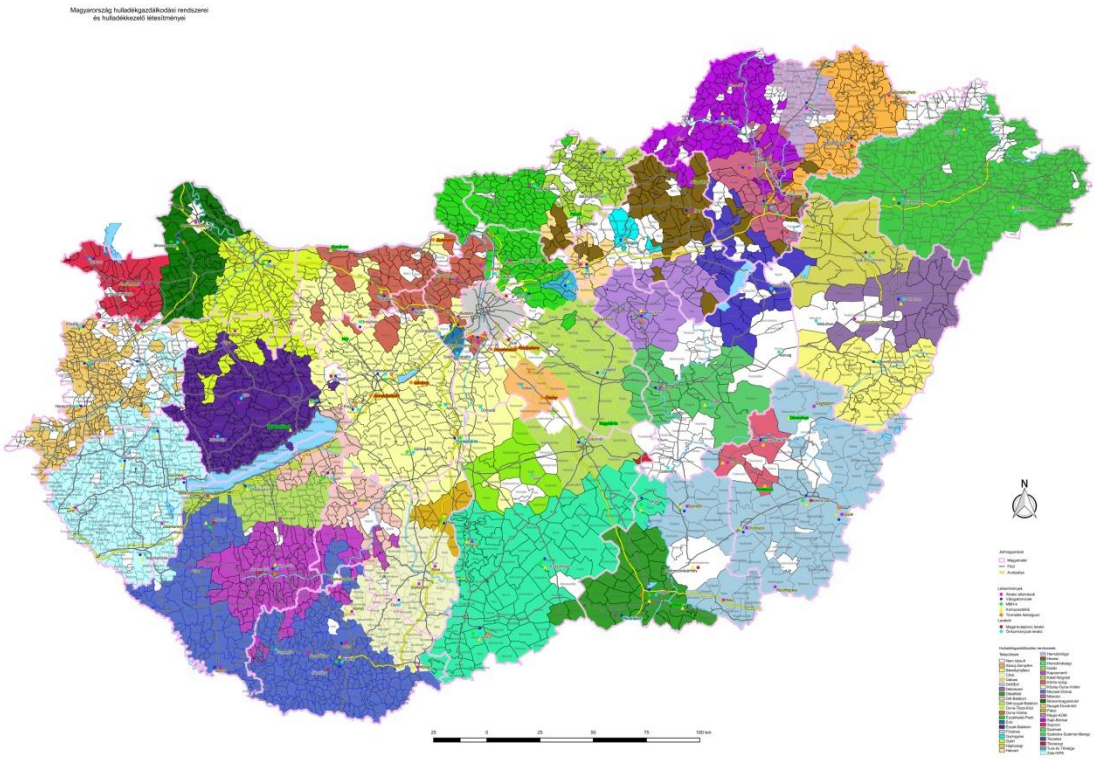
The optimal territorial boundaries of public service supply can be established based on a processing of the data supplied by the public service providers and the data and information collected from authorities. The existing waste management infrastructure, knowledge of the related obligations and considering the geographic, geologic and hydrologic, as well as transport capabilities of nature and society, optimum boundaries can be designated based on the following factors:

- When establishing collection and transport districts, the currently operating and non-operating infrastructure created from EU funds and other resources (public service providers, private companies) must be considered, as well as the opportunities for development thereof and the fact that the majority of the country's popularization lives in larger towns and their direct vicinity. In the interest of maintaining the operation costs and sustainability of the systems, essentially the districts should be established around these.
- When determining the collection zones and transport zones, in view of the European Union's directives and obligations related to return rates, –in the future the extension and improvement of overall separated selective waste collection can be extended in terms of both quantity and economics.
- One-phased waste collection and transport should be pursued, in which the transport distance within the collection district should not exceed 50 km. Where that is not viable, two-phased collection and transport logistics should be applied through a transfer station and covering a distance of no more than 120 km.[9]
- There should be no break in the public service area covered by one public service provider and public service providers should not be forced to pass through each other's areas during collection and transport. This requires that a facility directly ensuring waste treatment after collection and transport be located within the given public service area.
- When establishing public service districts, the largest possible districts should be established in view of the "proximity principle" and "economies of scale". The economic laws underpinning the fee formula also compel the enforcement of these principles.
- The public service district established should ensure the adequate servicing of the existing waste treatment facility - the system element operated by the public service provider - and the supply of the adequate quantities of waste required for efficient operation.
- The quantity and composition of waste generated by certain municipalities may vary depending on the number of inhabitants, plot ratio, population density, economic

development or level of tourist attraction. The costs of collection and transport may vary significantly. A service area of adequate size is capable of integrating or balancing these effects.

- With future developments, the waste treatment infrastructure associated with the new waste management region being created should be capable of meeting long term waste management expectorations.
- Professional guiding principles should be accentuated in the integration process as compared with politically determined and other guiding principles.
- The new system being created should consider the fulfillment of the obligations undertaken in the European Union subsidy contracts, the planned material streams and utilisation obligations. Essentially this means none other than consideration of the geographic boundaries of the associations awarded the subsidies. If the association boundaries hinder the creation of optimised districts, the possibility of certain local governments exiting must be examined. In the majority of cases this goes hand in hand with joining another association. In both cases prudent action is necessary as non-compliance with the utilisation obligations set forth in the subsidy contracts may lead to repayment of the subsidies. While the projects are underway, exit of association members is subject to the consent of the Managing Authority and an amendment of the subsidy contract.

The image below is an ample illustration of the fragmentation of the association boundaries and the isolation of many areas.



Association boundaries 2016. Waste Management systems in Hungary [5]

The Mecsek-Dráva Programme is instrumental in the performance of the waste treatment duties of the South Transdanubia *(Dél-Dunántúl)* region. By the end of 2016., the 302 municipalities serviced by Dél-Kom Nonprofit Ltd. covered the majority of the public service area of the region included in the Programme. The local government coordination deliberating the above-outlined factors and the expectations of the coordinator organisation pointed to the direction whereby Dél-Kom Nonprofit Ltd. was the best suited company to perform the regional duties. The ownership background of the company guarantees adequate professional background for preparing to perform the increased tasks.

2.1.5. The situation of the public service activities of Dél-KOM Nonprofit Ltd. until 2016

2.1.5.1. Establishment, development of Dél-Kom Nonprofit Ltd.

The company was formed by BIOKOM Ltd. at the end of the 90's. The aim of the establishment was to perform waste management public service duties in as large an area as possible in the region surrounding the city of Pécs. At the start, the company's activity consisted of collection, shipment and disposal of municipal solid waste, performed within the framework of public service. In this period the company's success was based on the low service fees. In 1998, the company had a contractual relationship with 18 municipal local governments for the

collection, transport and disposal of municipal solid waste generated by the population, institutions and the industrial-commercial enterprises. In addition to building the market position, technical and technological development conforming to constant market and local government expectations was also among the objectives to be achieved. With its services provided at competitive prices that also satisfied the local governments' special needs, the company proved a stable and reliable partner. As a result of the developments, basic service was supplemented by selective waste collection, provision of rented bins and the operation of own waste landfills. Thanks to the successful strategy the company's market position became stronger from year to year.

As of 1 July 2013–, in compliance with the statutory requirements–, Dél-Kom Ltd. continued its activities as a nonprofit company, therefore the company's name also changed to Dél-Kom Nonprofit Kft.

Dél-Kom Nonprofit Ltd. has applied the waste management public service fees based on the calculation method defined in Section 91 of the Waste Act since 1 July 2013, conforming to the objectives of utility price cuts. The fees did not provide sufficient cover for financing the landfill charge and the unrealised revenues arising from the statutory application of utility price cuts could not be counterbalanced by efficient cost management, therefore, in the 2014-2016 period the company carried out its activity and performed its obligations undertaken in the public service contracts by making losses.

The table below illustrates the Company's development:

	2005	2007	2009	2011	2013	2015	2016
Sales revenue (HUF)	227,558,000	311,213,000	593,373,000	865,228,000	1,152,345,000	1,278,937,000	630,686,937,000
Subsidy (HFU)	0	0	0	0	0	64,108,734	128,092.000
Landfill charge (HUF)	0	0	0	0	71,862,600	37,323,160	9,440,000
Profit before taxes (HUF)	21,685,000	44,752,000	29,981,000	68,815,000	-50,202,000	-215,277,000	190,072,000
Profit after taxes (HUF)	16,481,000	37,472,000	18,889,000	58,820,000	-53,734,000	-217,815,000	151,658,000
Number of municipalities served (pieces)	103	109	224	235	294	299	302

Population served (number	70,354	75,040	136,000	136,000	225,452	211,050	196,506
Communal waste treated (tons)		20,676	27,466	31,328	40,018	45,800	45,720
Number of employees / CSO (persons)	10.80	10.60	17.50	36.00	46.60	85.00	85.30

Source: Controlling data of Dél-Kom Nonprofit Ltd. [11]

The number of municipalities serviced was 302 at the end of 2016, covering the areas of Baranya County, Somogy County and Tolna County. Total number of properties 80,943 is the number of the population in the entire service area: 196,506 persons, the amount of collected waste in 2016:

Communal waste	45,720 tons
Selective waste (excl. glass and green)	2,029 tons
Glass waste	392 tons
Green waste	1,960 tons

The activities of the company are greatly influenced by the waste treatment infrastructure established from European Union funds by the local government associations formed in the region and the utilisation obligations associated with the subsidies. Within the programmes, the equipment required for performance of the waste treatment public service was established as local government property, then the associations, i.e. local governments provided or granted use of the equipment to the public service providers in conformity with the expectations of the subsidy contracts. Dél-Kom Nonprofit Ltd. joined the programme through the operation and use of the system elements related to its area of operation. The 302 municipalities joined two large programmes: 252 municipalities belong to the area of the Mecsek-Dráva Project, whereas 50 municipalities are part of the South-Balaton Sióvölgy Project.

2.1.5.2. The Mecsek-Dráva Programme

The equipment of the Mecsek-Dráva Waste Management Programme creates a stable basis for the operation of Dél-Kom Nonprofit Ltd. The main consideration in establishing the system from the start was to enhance efficient regional cooperation to every participating local government's advantage. The adequacy of this approach was proven by the number of

municipalities joining the Programme within the three counties of the Southern Transdanubia region: 318, covering a population of over 420,000. This cooperation at the community level, which is an exemplary result in every way in the field of enforcement of common local interests is also a regional historical event in Southern Transdanubia as it is the first cooperation that could be created as the result of collaboration between the local governments of three counties. With the re cultivation of the closed waste landfills, the programme minimises the environmental risks of irresponsible waste disposal in the past. The development realised from European Union funds established one of the modernest equipment systems in the country.

The main elements of the Mecsek-Dráva Programme in the supply of public services by Dél-Kom Nonprofit Ltd:

- Kökény Waste Treatment Centre
    - Mechanical Biological Waste Treatment Centre
    - Bio-stabilisation area
    - Composting plant
    - Municipal solid waste landfill
    - Material Recovery Facility (manual sorting)
- Barcs Waste Treatment Centre
    - Material Recovery Facility (manual sorting)
- Transfer stations (Pécs, Barcs, Szentlőrinc, Kaposszekcső)
- Civic Amenity sites (wasteyards, 16 units)
- Transport vehicles
- Selective collection islands, selective storage bins

The complex system created by the programme enables the minimisation of the quantity of waste being landfilled through the operation of the Kökény Waste Treatment Centre. The technology employed in the plant – mechanical-biological waste treatment (MBWT) – serves the treatment of unclassified municipal waste by combining classification and densification processes with biological drying. Its purpose is to reduce the environmental hazardousness, volume and weight of waste, stabilisation of waste and to extract usable materials to extract refuse-derived fuel (RDF).[12] The high heating value (12-15 MJ/kg) refuse-derived fuel thus produced can be utilised in the cement factories in Beremend and Királyegyháza nearby. The objective of the waste treatment technology is to comply with the requirements –in respect of pre-processing, reduction of organic material content proportion, material recovery and minimisation of the quantities deposited in landfills – such as to keep costs at the lowest possible level.

As a result of the Mecsek-Dráva Programme, a complex, up-to-date but also cost-effective collection and processing system works at the municipalities in which selective collection is carried out at all municipalities. Thanks to the developments, the amount of waste deposited in landfills can be reduced to below 40%.[11]

2.1.5.3. The South-Balaton Sióvölgye Programme

The Tolna County municipalities of Dél-Kom Nonprofit Ltd. belong to this area. This programme was formed about ten years earlier than the other large project. The infrastructure created represents a lower level, in conformity with earlier statutory requirements.

The key elements of the equipment and means of the Dél-Balaton Sióvölgye Programme operated by Dél-Kom Nonprofit Ltd. are the following:

- Cikó Waste Treatment Centre
    - Municipal solid waste landfill (No pre-processing, the waste landfill constantly struggles with technical, leachate treatment problems.)

Pre-processing of municipal solid waste prior to depositing is not taken care of in the area, nor is the sorting of selective waste or the composting of green waste. The manual sorter and the composting plant were constructed but did not operate in 2017. The main problem of the centre is that the volume of incoming waste - 50,000 tons/year - does not enable the economic operation of the infrastructure required for pre-processing and processing of waste.

2.1.5.4. Content elements of the public service

Collection of mixed communal waste occurs with the emptying frequency defined in the public service contracts or local decrees.

Collection of secondary raw materials takes place at all of the municipalities of the service area with the establishment of collection points or a door-to-door system. At the collection points – depending on the number of inhabitants in a certain municipality – 3 fractioned (paper, glass, plastic) 1,100 litre bins are placed in each municipality. The number of collection points in 2016: 561. The improved version of the selective collection system at the collection points is the so-called “door-to-door” system. Selective collection is carried out in this form in 97 municipalities. In addition to collection of plastic, plastic and glass, in 37 municipalities (exceeding 50% in terms of population) the company collects compostable green waste separately. The wasteyard network encourages selective collection and prevents the formation of illegal waste landfills.

Dél-Kom Nonprofit Ltd. operates 16 waste yards, the Barcs Regional Waste Treatment Centre (transfer and sorting) and the Szentlőrinc transfer station. Treatment and disposal of a large

part of waste collected in wasteyards, bulky waste, green waste and selectively collected waste is carried out at the Kökény Waste Treatment Centre operated by BIOKOM Nonprofit Ltd. The mixed communal waste of the municipalities belonging to the Sióvölgye programme is an exception as it is taken to the Cikó waste landfill. The Barcs Regional Waste Treatment Centre sorts the selective waste of the Barcs area. The Szigetvár Waste Landfill owned by the company is operated as a safety reserve. The facilities participating in waste treatment and waste disposal carry the required environmental licenses and are specially engineered and comply with the applicable environmental requirements.

The Central Customer Service Desk is in Pécs, while customer service desks operate in Szigetvár, Siklós, Harkány.

As of 1 April 2016, the statutory circumstances changed significantly compared with the previous years. Accordingly, as of 1 April 2016 Dél-Kom Nonprofit Ltd. was not entitled to issue an invoice for its waste management public service activity, the invoices are issued by the collector of the public service fee, i.e. the National Waste Management Coordination and Asset Management Ltd. Dél-Kom Nonprofit Ltd. carries out waste collection, shipment and treatment public services and customer service activities.

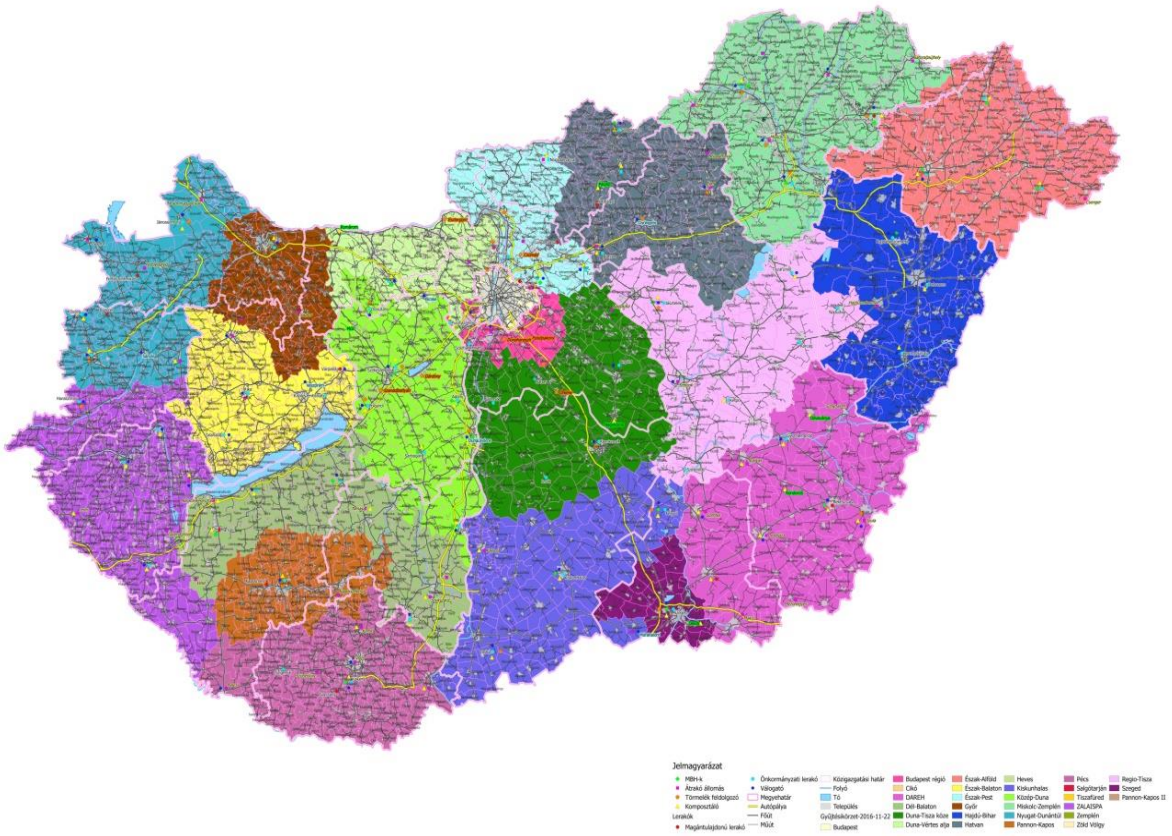
The size of the service area, the collection system operated and the waste processing technology are suitable for funding the costs incurred during performance of the public service tasks by means of the service fee calculated based on the fee formula under intense management in the renewed public service system. The fee is insufficient for financing significant developments or replacement of worn equipment.

The service standard and the acceptance thereof are demonstrated by the fact that since the establishment of the company, the contracts with the various local governments have continuously existed and the number of contracts has continuously grown. During its operation the company strove to provide the highest standard of service within the framework of statutory and financing possibilities, in conformity with environmental considerations. The acceptance of Dél-Kom Nonprofit Ltd. made the integration organisational processes easier.

2.1.6. Integration of Dél-Kom Nonprofit Ltd. in 2017

2.1.6.1. Improvements of the integration process

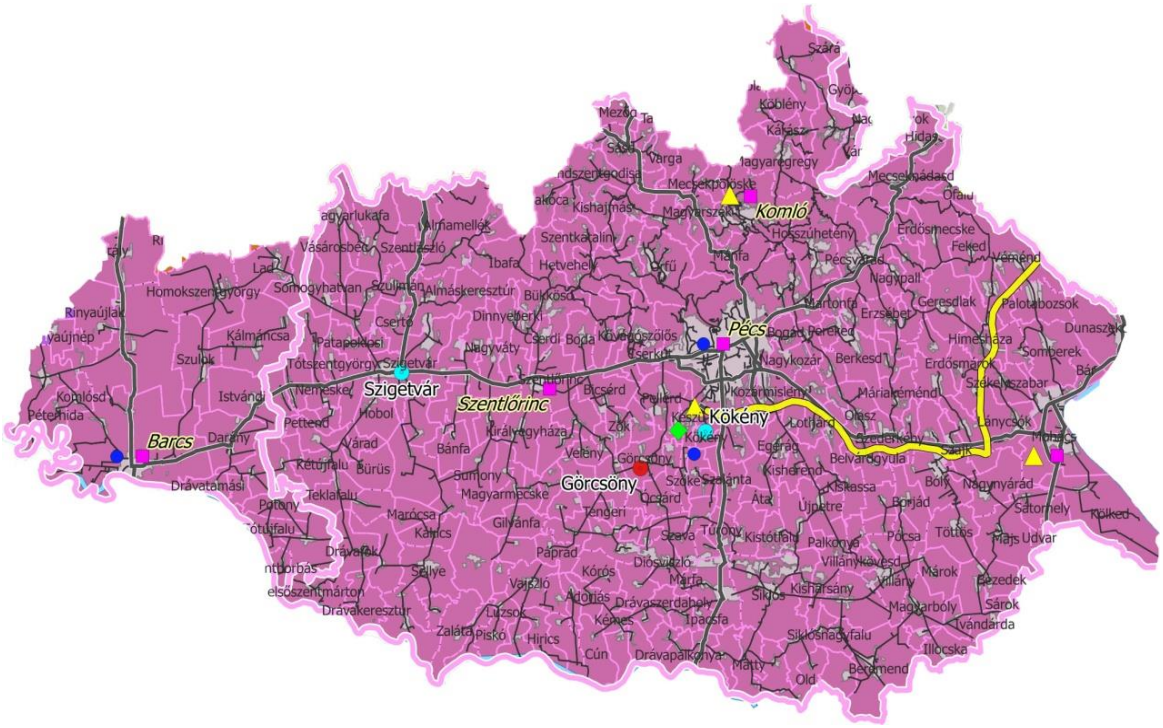
The 23 November 2016 Siófok conference of the Public Sanitation Association can be considered as a milestone in the acceleration of the integration processes. The boundaries of the 21 public service areas defined in optimised by the NHKV Zrt. were published at this forum.



Optimised public service map 2017.[5]

The ideal public service provider size was defined at the forum as 300,000-500,000 persons. In addition to the boundaries, at the conference the optimum public service regional infrastructures were also outlined in detail at the conference. The boundaries of the Pécs Region covered the public service area of the BIOKOM company group, supplemented by the Mohács collection district.

This is demonstrated by the following image:



Optimised public service areas: Pécs Region[5]

The representatives of the public service providers were asked to start negotiations to explore the possibilities for cooperation and integration solutions and for establishing new public service areas. The need for change could be felt as the majority of public service providers, especially those with smaller plant size, struggled with serious financing and liquidity problems in that period.

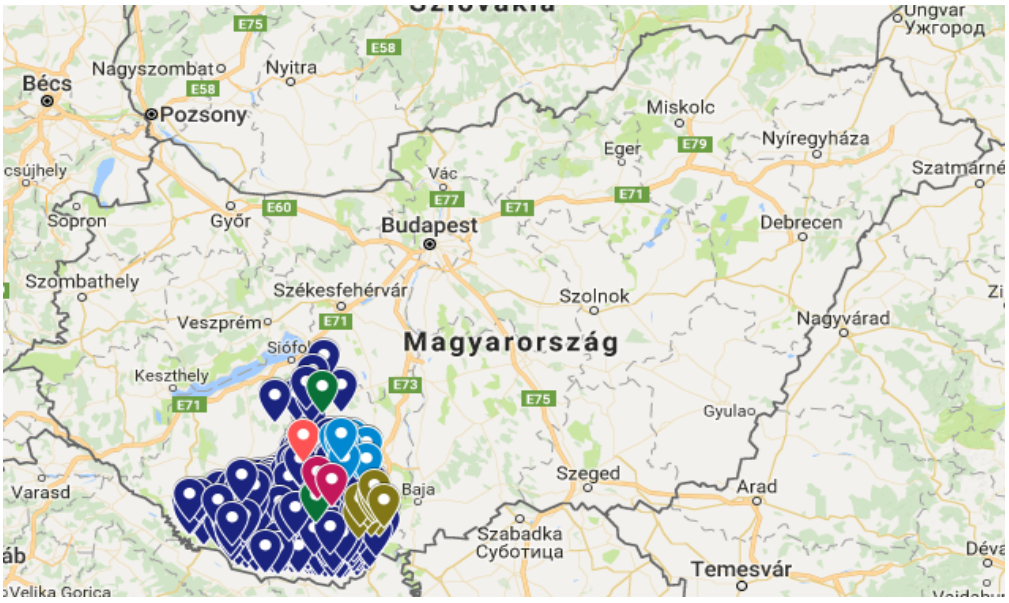
The next boost for the integration process was brought about by the review of Conformity Opinions. In the first months of 2017, as a result of the review of data supply, NHKV Zrt. revoked the Conformity Opinion of the public service providers lacking adequate operating parameters. Companies without licenses – as provided by applicable law – were only allowed to carry out their public service duties for 6 months following revocation.

The conformity opinion of Dél-Kom Nonprofit Ltd. was not withdrawn, therefore, it continued its public service tasks. Negotiations accelerated regarding the takeover of designated areas and expansion of public service area.

The preparatory works of the integration processes were carried out in order to ensure the least possible problems and disruptions during the 2017 expansion -– as expected by the owners of the company and the population– - in the undisturbed performance of public service tasks, in conformity with the professional, economical, legal, labour, financial and accounting expectations as well.

During 2017, the public service area of Dél-Kom Nonprofit Ltd. kept expanding with the areas received from other public service providers which are demonstrated on the map below:

- BIOKOM Nonprofit Kft. (Pécs)
- Bonycom Nonprofit Ltd. (Bonyhád and surrounding area)
- Mohács Town Management and Ferry Shipping Nonprofit Ltd. (Mohács and surrounding area)
- Komló Town Management Nonprofit Ltd. (Komló and Hosszúhetény)
- ÖKO-DOMBÓ Nonprofit Ltd. (Dombóvár)
- Dél-Kom Nonprofit Ltd. (public service areas 2016.)



South-Dunántúli public service areas, April 2016

2.1.6.2. Expansion of the public service area

The Local Government of Pécs County Town cooperated in the realisation of the transformation and integration of the public service system affecting the South Transdanubia Region. Based on the decision of the town assembly as of 30 April 2017, the waste management public service activity of BIOKOM Nonprofit Ltd. ended in Pécs County Town. By its Decision 91/2017 (04.27.) the Local Government of the County Town of Pécs decided that as of 1 May 2017 for five years Dél-Kom Nonprofit Ltd was appointed for performing waste management public service tasks. Under Section 9 (1) i) , of Act CXLIII of 2015 on Public Procurement conclusion of the public service contract did not qualify as a transaction subject to public procurement in view of the indirect ownership by the Local Government – through BIOKOM Nonprofit Ltd.

In Mohács, Bonyhád and Komló the public service tasks were performed by the smaller companies owned by the towns (population equivalent of 20,000 - 30,000). The local governments – being aware of the status of the companies owned by them – understood that

in the extremely difficult legislative and financing environment faced by the public service providers currently operating with a relatively small plant size without up-to-date waste treatment infrastructure, their companies would be unable to perform waste management public services at the expected standards, degree of efficiency and safety on the long run. A rethinking of the status and organisational structure of the companies became expedient and justified. The review did not just cover the relationships within the companies but also analysed under what conditions they would be able to safely perform the expected standard of public service on the long run in the new regulatory system, keeping the profitable operation of the other sectors of the companies. The most adequate solution appeared to be the outsourcing of the waste management activity of the public service provider to– an already existing nonprofit company also in the business of waste management public service–. The towns recognised the opportunity for cooperation in the BIOKOM company group. Following detailed negotiations at the right levels that explored all the opportunities and solutions, –an agreement was reached based on the mutual trust and consent of the parties. The cooperating partners considered Dél-Kom Nonprofit Ltd. as the most suitable entity to perform the regional tasks.

The waste management public service activity of Mohács Town Management and Ferry Shipping Nonprofit Ltd., owned by the town of Mohács seceded with legal succession from the company on 31 March 2017 and merged into Dél-Kom South-Transdanubia Communal Service Nonprofit Ltd. As a result of the transformation, as of 1 April 2017, the legal successor of the waste management public service contract for the provision of services to 10 municipalities serviced by the legal predecessor Mohács Town Management and Ferry Shipping Nonprofit Ltd. (MOHÁCS, LÁNYCSÓK, KISNYÁRÁD, SZAJK, SZÉKELYSZABAR, ERDŐSMÁROK, GÖRCSÖNYDOBOKA, SOMBEREK, PALOTABOZSOK, Bár) is Dél-Kom Nonprofit Ltd.

The earlier public service provider of the town of Bonyhád, Bonycom Nonprofit Ltd. ended its public service on 30 April 2017. The registered capital of Dél-Kom Nonprofit Ltd. was raised, during which the town of Bonyhád obtained a share in the value of HUF 100.000. With the acquisition of a share in Dél-Kom Nonprofit Ltd by the local government, the public service contract in the town of Bonyhád was not subject to a public procurement procedure, Dél-Kom Nonprofit Ltd. could be designated as the entity to perform waste management public service without conducting public procurement. The town local government issued Decision No. 88/2017 (IV.27.) whereby as of 1 May 2017, they would conclude a contract with Dél-Kom Nonprofit Ltd. for a 10 year period. As of 1 May 2017 the waste management public service provider of the area earlier serviced by Bonycom Nonprofit Kft. (BONYHÁD, BONYHÁDVARASD,

IZMÉNY, KISDOROG, KISVEJKE, Nagyvejke, Kakasd, APARHANT, LENGYEL, MŐCSÉNY, MUCSFA, VÁRALJA, ZÁVOD) is Dél-Kom Nonprofit Ltd.

The public service activity of the public service provider of the town of Komló, i.e. Komló Town Management Co. Ltd. ended on 30 June 2017. The registered capital of Dél-Kom Nonprofit Ltd. was raised, during which the town of Komló obtained a share in the value of HUF 100.000, therefore Dél-Kom Nonprofit Ltd. could be designated as the public service provider without a public procurement procedure. With Decision 55/2017 (04.28.) of the Komló Town Assembly, as of 1 July 2017, the town of Komló also joined the service area of Dél-Kom Nonprofit Ltd.

The earlier public service provider of Hosszúhetény was the Komló Town Management Co. Ltd. The local government concluded the contract with Dél-Kom Nonprofit Ltd. for a transitional period until completion of the public procurement proceeding. Dél-Kom Nonprofit Ltd. applied in the public procurement proceeding and won the public service as of 01.01.2018.01.01.

A special situation ensured in the town of Dombóvár. The area integration attached the town to the Kaposvár district. Due to the obligations of the municipality belonging to the Mecsek-Dráva Programme arising from association membership and the maintenance obligations of the programme the details of the secession could not be clarified until late 2016. The Kaposvár public service provider - in the absence of transport vehicles and free capacities - was unable to fulfill the tasks. To solve the problem, as of 30 June 2017, the waste management public service duties of ÖKO-DOMBÓ Nonprofit Ltd. were taken over by Dél-Kom Nonprofit Ltd. on a temporary basis.

2.1.6.3. Changes in the service area of Dél-Kom Nonprofit Ltd

Rationalisation of the service area also involved the transfer of certain areas. The table below illustrates the municipalities attached to the Szekszárd collection zone betwen 01 April - 30 September 2017.

NEW PUBLIC SERVICE PROVIDER	TOWN NAME	INHABITANTS
SOUTH-BALATON REGION	BELECSKA	349
	ÉRTÉNY	783
	FELSŐNYÉK	980
	KOPPÁNYSZÁNTÓ	296
	NAGYKÓNYI	1097
	NAGYSZOKOLY	903
	ÚJIREG	282
TOTAL:	**7**	**4,690**

Municipalities separating from the service area of Dél-Kom Nonprofit Ltd.[1]

As a result of the integration process within a few months the service area more than doubled. The table below contains the towns taken over between 1 April 2017 and 30 September 2017:

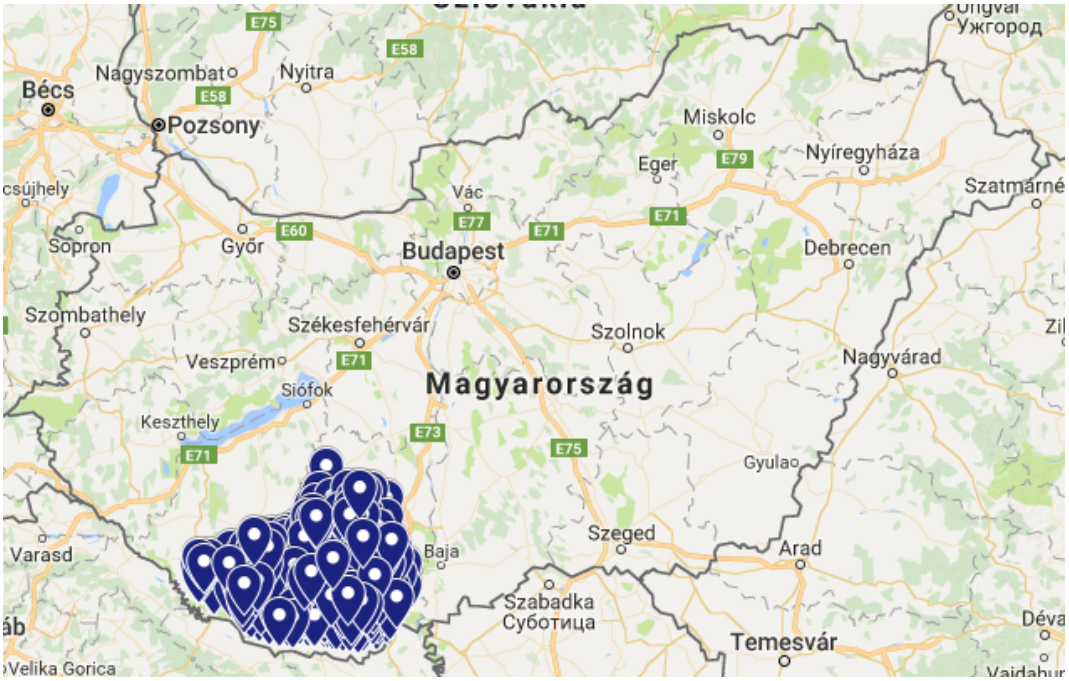
THE EARLIER PUBLIC SERVICE PROVIDER	TOWN NAME	INHABITANTS
BIOKOM Nkft.	PÉCS	145,347
MOHÁCS REGION	BÁR	530
	ERDŐSMÁROK	88
	KISNYÁRÁD	167
	LÁNYCSÓK	2,397
	MOHÁCS	17,355
	PALOTABOZSOK	865
	SOMBEREK	1341
	SZAJK	812
	GÖRCSÖNYDOBOKA	370
	SZÉKELYSZABAR	541
BONYHÁD REGION	BONYHÁD	13,322
	BONYHÁDVARASD	407
	IZMÉNY	465
	KISDOROG	731
	KISVEJKE	297
	APARHANT	985
	LENGYEL	532
	MŐCSÉNY	375
	MUCSFA	357
	VÁRALJA	846
	ZÁVOD	285
KOMLÓ REGION	KOMLÓ	23,388
	HOSSZÚHETÉNY	3,360
DOMBÓVÁR	DOMBÓVÁR	18,461
TOTAL:	**25**	**233 624**

Towns taken over during the 2017 integration [11]

Changes in the service area of Dél-Kom Nonprofit Ltd. compared with fall of 2016.

2016 1 APRIL	301 municipalities	**194,231 inhabitants**
2017 30 SZEPTEMBER	319 municipalities	**423,165 inhabitants**

The Southern Transdanubia Region created as a result of the integration process is demonstrated by the map below:



The service area of Dél-Kom Nonprofit Ltd. 30 September 2017[11]

2.1.7. Evaluation of the integration of Dél-Kom Nonprofit Ltd

2.1.7.1. Standard of waste treatment

The integration of the public service activity does not merely comprise and increasable of rthe service area, but also rationalisation and transfer of material streams. The communal waste belonging to the Southern Balaton Sióvölgye programme (in Mohácsi, Bonyhád, Pécsvárad, Komló) was earlier disposed in the Cikó waste landfill without pre-processing. This did not comply with the expectations of either the laws or the coordinator organisation. As the obligation to maintain the programme expired, after the collection zones joined, processing was carried out at the Kökény Waste Landfill Centre. The capacity of the facility can take the processing and the transport costs are counterbalanced by the excess revenue earned from processing and saving on landfill costs.

In 2018 by redirecting material stream, instead of simple landfill of about 25,000 tons, after obtaining the useful materials and bio-stabilisation, about 10,000 tons less waste is deposited

in the landfill. In addition to the environmental benefits, it also results in cost savings, and due to the positive correction of the fee formula, an increase of revenues.

2.1.7.2. Costs of mechanical biological waste treatment (MBWT)

50% of the costs of the MBWT plant are permanent costs, which do not increase further with the increase of the quantity of waste processed. The investment-related utilisation fee arising from the formation of amortisation belongs here; as well as the costs of plant-maintenance, insurance, security, fire protection, organisational and control. Prior to the integration the base volume of the facility was about ~100 000 tons/year. In 2018, as a result of the expansion process - 25,000 more tons of waste are processed in the plant, therefore the permanent costs per tonne will be reduced by 20%.

With an increase of the volume the efficiency of the plant grows significantly and the processing cost per tonne is reduced by 10%.

2.1.7.3. The fee/unit

The number of people serviced by Dél-Kom Nonprofit Ltd. during 2018 was 420,000. The public service provider size multiplier of the fee formula increases the positive correction factor by 40%, while the negative correction factor is reduced by 20%. In 2016, the multiplier raising the positive correction was 1.25; the one decreasing the negative to 0.9.

As a result of the integration process, the annual averages of the quarterly changing unit charges were as follows:

Unit charges 2016	Unit charges 2017	Expected unit charges 2018
HUF 2.75 / litre	HUF 3.12 / litre	HUF 3.25 / litre

The average fees of Dél-Kom Nonprofit Ltd.

As a result of the riser of the fee per unit the public service provider receives larger sales revenue for equivalent activty. The sales revenue per household enables an expansion of the separation efficiency of the MBWT plant, an increase of the service standard and the provision of extra services.

Possible extra services:

- expansion of door-to-door selective waste collection, increase emptying frequency;
- development of the glass waste collection system;
- increase frequency of bulk waste collection;
- expansion of door-to-door collection of green waste, increase emptying frequency;

- increase of number of times for Christmas tree collection;
- organisation of communications campaigns in the interest of increasing the efficiency of the system;
- organisation of storage bin cleaning;
- renovation of worn public area selective collection bins.

2.1.7.4 Evaluation of the integration of Dél-Kom Nonprofit Ltd

During 2017 Dél-kom Nonprofit Ltd. - conforming with the expectations of the national coordination organisation and the operating obligations of the Mecsek-Dráva Waste Management Programme - became a large regional public service provider. The number of persons serviced exceeds 423,000. The quantity of waste collected and treated within the framework of public service is expected to reach 150,000 tons in 2018.

The transport and waste treatment means and equipment provided by the region's programmes are able to meet the public service tasks of the service area with a higher degree of efficiency. By the increase of the volume, the utilisation of the system approximates the maximum of its capacities. With the takeover of the operation of the Kökény facility, the principle of self-sufficiency is also met. This plant is the final destination of collection and shipment tasks. Its location near the centre of the operating area creates a favorable position, with the operation of the 7 ideally located transfer stations, for keeping shipment at low cost levels. Thanks to the technology of the Kiökény Waste Treatment Centre, only 40% of the wastes of the region is placed in the waste landfills after bio-stabilisation. The materials generated (refuse-derived fuel, secondary raw materials, compost) aid the realisation of circular economy by sparing natural resources.

With the development of the selective waste collection and the MBWT plant, which are ongoing and are expected to be completed by 2018 and 2019, the utilisation rate can be further increased for fulfillment of the obligations required by the Waste Framework Directive for 2020 even in respect of all the waste generated in the region.

On the increased service area a uniform public service system was created with the standardisation of the public service contracts and the local decrees. This means that the detailed rules of the transparent and more organised activity conform to the changed legislative expectations.

The financing status of the public service system improved thanks to the quality and quantity parameters and the increase in the population numbers serviced and value of the unit charge grew. The operation of the company became profitable even with the maintenance of the achievements of utility price cuts, formation of provisions and meeting refurbishment obligations.

2.2. Technical data of the Pécs area waste management

2.2.1 Logistics and infrastructural background of waste collection and treatment

The waste management of the border region is defined for several decades by the infrastructure created under the Mecsek-Dráva Program, accompanied by well-defined logistic solutions. Collection and treatment are basically organized around two main material streams: municipal wastes subject to mixed collection and separately collected wastes. From the environmental point of view, the basic principle would be to maximize the yield of recycled materials for both material streams, but for the sake of economic sustainability, this should be qualified in the light of the prevailing financing (and legislative) environment. The facilities are therefore designed in such a way that the treated material can be removed from the system at several levels of processing/refining.

Mixed waste collection and management

In order to process mixed waste, a mechanical-biological treatment centre was established in Pécs-Kökény. In the area of the project, collection districts have been established, the transport vehicles either transport the waste directly to the treatment centre or to the transfer stations established at the central settlements of the micro-regions. In the latter case, the waste of the collection district is loaded into trailers with moving floors, and then transported in those to the mechanical preparation plants.

Within the framework of the Mecsek-Dráva Program, 4 transfer stations were established with the following annual capacities:

Barcs: 12 thousand tons
Kaposszekcső: 14 thousand tons
Pécs: 12 thousand tons
Szentlőrinc: 15 thousand tons

The mechanical-biological treatment centre performs the mechanical pretreatment of non-separately collected waste and the biological treatment of separated, decomposing organic waste.

Most important steps of mechanical treatment:

- pre-selection of the waste received by laoder
- pre-crushing (<350mm), loosening of waste
- metal deposition by magnetic separator

- sifting through drum screen of 60mm granular size (separation of organic fraction)
- metal deposition by eddy-current separator
- heavy fraction separation by air-blast system
- post-crushing of light fraction (<50mm)
- light fraction removal in bulk, or baled

Steps of biological treatment:

- stabilisation in closed hall
- stabilisation in open space
- metal deposition by magnetic separator
- light fraction separation

The mechanical-biological treatment plant has three outlets:

- the light fraction may be deposited or transferred as a combustion feedstock for power plant and cement works co-incineration;
- The purified stabile can be used for recultivation or is deposited at a landfill;
- The heavy fraction is deposited at a landfill.

In order to place non-recoverable wastes, a landfill will be built in Kökény with a capacity of 850,000 m3, which can receive the waste of Pécs and its region for decades.

Separate waste collection and treatment

1. Collection by collection island

In the project area, at least one collection point was established in each settlement. In addition, in settlements with a population of 500 to 1,000 people, an additional island was placed, and above that one additional collection island per thousand inhabitants each, i.e. a total of 820 collection islands were built.

2. Door-to-door collection

Door-to-door separate collection has been introduced in the districts of towns with family houses and within a 20 km range of settlements with more than 15,000 inhabitants. For collecting, 240-litre individual collection bins were placed. Paper, plastic, metal and combined packaging can be collected in this bin. Separate collection of glass waste is carried out in glass collection containers placed in public areas. Door-to-door, recoverable waste collection is done every other week.

In Pécs, in the housing estates - in addition to the collection islands - separate collection in stairways is also successful. In order to expand this system, 1,100-litre bins were placed, in

which paper, plastic, metal and combined packaging can be collected similar to the collection at family houses.

3. Green waste collection

Door-to-door green waste collection has been successful since 2003 in the garden districts of Pécs. For collecting, 80-litre individual bio waste collection bins were placed. The capacity of the new green waste composting plant in Kökény is 9,750 tons/year.

4. Civic Amenity sites (wasteyards)

In the wasteyards, separately collected waste generated by the public (paper, metal, plastic, green waste, etc.) large size wastes (furniture, bulky waste) and household appliances can be disposed of. Here, there is also the possibility of collecting “problematic” waste generated by households (paint containers, dry batteries, expired medicaments, electronic waste, etc.).

5. Material Recovery Facilities (sorting plants)

The manual sorting plant performs the industrial preparation of separate mixed wastes (paper, plastic, metal). The waste received is sorted into different factions according to the needs of the industry, and then bales are created from pure-line materials. The final product of the sorting plant is the bale, which is sold and thus recycled.

The sorting of waste requires a considerable amount of manual work, so in the region it may offer jobs for those doing light physical work in the region.

The role of sorting plants in the formation of the population’s consciousness is not negligible, since it is the most popular and most “spectacular” destination for plant visits by kindergarten and primary school age groups.

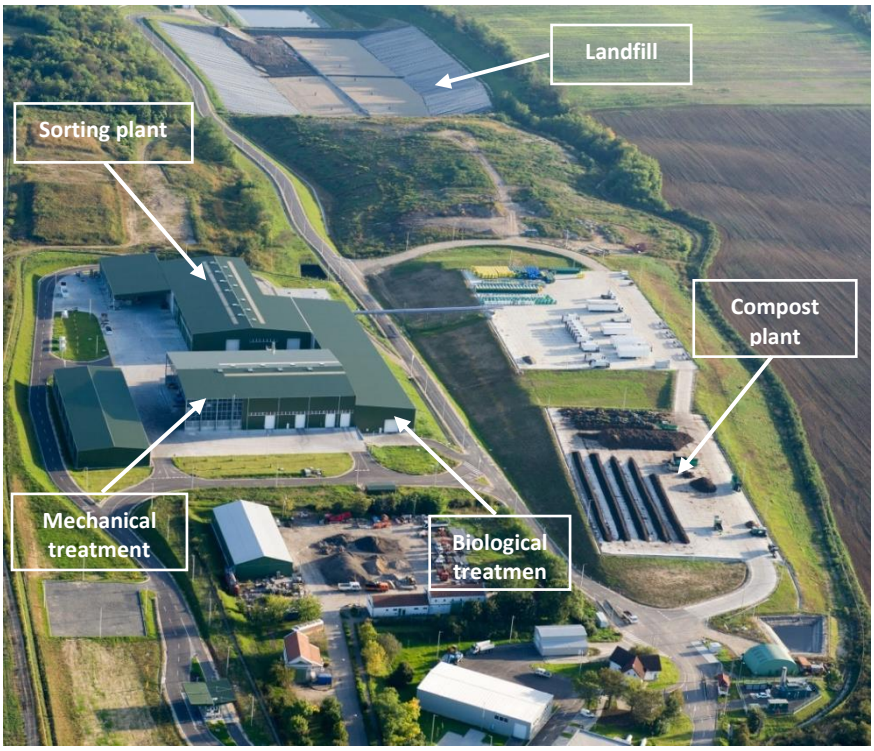


Image: The most important waste treatment infrastructure in the region is the regional waste treatment centre located in Pécs-Kökény

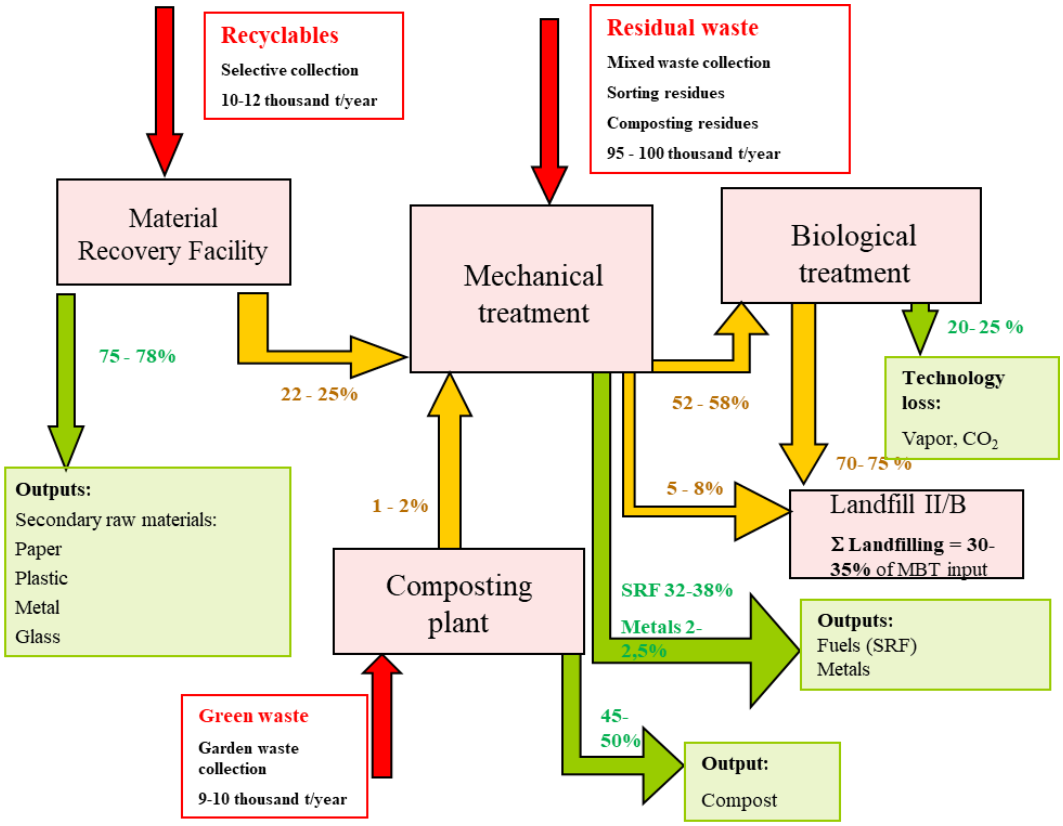


Figure: Internal waste streams of the Pécs-Kökény site

Waste is moved and treated both outside and within the site, in order to maximize the yield of recycled materials and to make the most valuable “end product” from a given waste stream. Of the wastes collected at the site of the generation, green waste is transferred into the composting plant (bottom of figure), and the dry packaging materials are taken to the manual sorting plant (top left-hand section of figure).

- We receive back 45-50% of the mass of 9-10 thousand tons of incoming green waste as ready-made compost, which we sell for purposes of soil improvement. The remaining 50-55% will be released in the form of gases and vapours, except for 1-2% foreign matter which will be transferred to the mechanical treatment unit after separation.
- The 10 to 12,000 tons of dry packaging material collected separately is sorted at a manual sorting plant, if possible, into pure-line secondary raw materials by the conveyor belt workers. Paper, plastic and metal raw materials of various qualities are sold in bales, glass is sold in bulk. This accounts for 75-78% of the incoming mass. It is important to note that glass waste is not transferred onto the sorting belt in order to avoid personal injuries. Sorting residue (approx. 22-25%) is taken to the mechanical treatment plant.
- The 95 to 100,000 tons of residual waste from mixed collection is delivered to the mechanical treatment unit. The waste transferred from the composting plant and the manual sorting plant, which can no longer be recovered materially is added to this quantity. In the manner described above in the section on “mixed waste collection and treatment”, organic decomposing, heavy and light (plastic, paper, wood, textile) fractions as well as metals are separated from each other. Secondary fuel (SRF) is produced from light fraction, accounting for 32-38% of the incoming waste mass. Separate magnetizable and non-magnetizable metals represent another 2 to 2.5. The 5-8 percent of heavy fraction (gravel, glass tiles, etc.) is deposited directly.
- Organic fraction from the mechanical treatment plant is first stabilized in a closed hall and then in an open space. This is the same technology as composting, however, due to the collection method of the treated material, legislation does not refer to this as composting but rather as stabilization, and the final product is not called compost but stabilate. The purpose of stabilization is for the decomposition of organic materials to take place under controlled conditions, preferably under aerobic conditions, thus to ensure that CO_2 is produced and not methane, which is a typical by-product of traditional landfills (most of the global emissions of methane with strong greenhouse effect are attributable to landfills and cattle farming). 52 to 58% of the quantity

delivered to the mechanical treatment unit arrives at the stabilizing space. As a result of biological treatment, one-foruth/one-fifth of the treated volume is removed in the form of gases and vapous and 75-80% is deposited.

The possibilities for further development are discussed in chapter 3 of the study, but it is worth noting at this point already that it is confirmed by the numbers in the figure that by improving the separate collection and utilization of organic decomposable waste and plastic waste, the greatest improvement could be achieved both from an environmental and an economic point of view.

2.2.2 Waste streams

In the course of the characterization of the northern side of the border, the waste streams delivered to the Pécs-Kökény Regional Treatment Centre are presented and the quantities collected in Pécs will be highlighted.

2.2.2.1. Delivery data

Waste streams delivered to the Pécs-Kökény regional treatment centre in 2017

Plant area	kg
Compost plant	9302560
Mechanical-biological pretreatment plant	99 476 693
Material Recovery Facility	6,324,760
Total:	115,104,013

From the above table it is apparent that the vast majority of the waste delivered to the treatment centre from nearly 320 settlements was transferred to the mechanical-biological treatment unit, i.e. it was derived largely from mixed collection. It should be noted that approx. 90% of the 9,302 tons of organic waste delivered to the composting site was generated in Pécs, half of which was produced by the population and the other half originated from businesses, institutions and urban park maintenance.

Distribution of wastes collected from the inhabitants in Pécs city in 2017

Type of waste	Collection mode	Collected kg	Distribution (%)	Collected kg per person	Collected kg per household
Mixed municipal waste	**Door-to-door**	**31,565,345**	**74.8%**	**210**	**526**
Bulky waste	Door-to-door	1,037,920	2.5%	7	17
	Wasteyard	12,424,20	2.9%	8	21
	Total:	**2,280,340**	**5.4%**	**15**	**38**
Green waste	Door-to-door	4,178,720	9.9%	28	70
	Wasteyard	309,735	0.7%	2	5
	Total:	**4,488,455**	**10.6%**	**30**	**75**
Paper waste	Wasteyard	66,548	0.2%	0	1
	Collection island	298,810	0.7%	2	5
	Total:	**365,358**	**0.9%**	**2**	**6**
Glass waste	Wasteyard	31,140	0.1%	0	1
	Collection island	442,120	1.0%	3	7
	Total:	**473,260**	**1.1%**	**3**	**8**
Plastic waste	Wasteyard	30,773	0.1%	0	1
	Collection island	594,830	1.4%	4	10
	Total:	**625,603**	**1.5%**	**4**	**10**
Metal waste	Wasteyard	**44,863**	**0.1%**	**0**	**1**
Separate mixed (paper, plastic, metal) waste	Door-to-door	**2,318,960**	**5.5%**	**15**	**39**
Hazardous waste	Wasteyard	**32,584**	**0.1%**	**0**	**1**
Total recoverable		**8,349,083**	**19.8%**	**56**	**139**
Total quantity collected		**42,194,768**	**100%**	**281**	**703**

Source: [11]

Approximate demographic data used to calculate specific indicators in Pécs:

Population (persons)	150,000
Households (pcs)	60,000
Average number of persons in household	2.5

In the above table containing 2017 data, only the data in the first line refer to traditional mixed collection, all other waste being collected separately. We did not calculate the separately collected bulky waste into the aggregate of recoverable wastes.

It is important to highlight on the list the line “Separate mixed (paper, plastic, metal) waste”, because this method of collection is not common in Europe: most of the packaging materials is collected in such a way that the residents place paper, plastic and metal into the same container. This reduces the number of separate collection bins inside the apartments and those placed on the street. Although this logistics solution requires extra work during manual sorting, collection itself is easier for residents and collecting organizations as well. This model was already operating in the ‘90s in the city of Guelph, Canada, under the name of “wet-dry recycling”, with two separately collected waste streams present in addition to the residual waste, including dry packaging materials and kitchen and garden wastes with high moisture content. In the case of separate mixed waste stream mass ratios in Pécs, the most important is the paper and cardboard fraction, which is followed by plastic, while metal represents the smallest ratio.

Distribution of wastes collected in Pécs city in 2001

Type of waste	Collected kg	Distribution (%)	Collected kg per person	Collected kg per household
Mixed municipal waste	**36,603,000**	**93.5%**	**229**	**610**
paper	1,850,000	4.7%	12	31
metal	312,000	0.8%	2	5
plastic	175,000	0.4%	1	3
glass	118,000	0.3%	1	2
bio, organic waste	0	0.0%	0	0
rubber	56000	0.1%	0	1
battery	12000	0.0%	0	0
other hazardous waste	4000	0.0%	0	0
Separate collection total	**2,527,000**	**6.5%**	**16**	**42**
Total quantity collected	**39,130,000**	**100.0%**	**245**	**652**

Looking at the data of the years 2001 and 2017 it is conspicuous that the amount of collected waste per capita increased from 245 to 281 kg, but it also tripled as to the proportions and volume of the recoverable, selectively collected portion. In this increment, the introduction of

the separate collection of green waste plays a decisive role, moreover, the amount utilized by home composting does not even appear in the collection data.

The increase of separate collection of plastic and glass waste at nominal value is striking. In the case of plastic, this is especially important, as due to the above-mentioned "Separate mixed (paper, plastic, metal) waste" collection, a large portion of the volumes still appearing separately in 2001 was allocated to this "separate mixed" item, as indicated by a radical decrease in paper and metal expressed in nominal value.

This comparison can be supplemented by data from separate collection outside of Pécs, due to the fact that corporate statistics prepared for county planning programs at the beginning of the 2000s are still available. The following table shows the details of Pécs and the settlements outside of Pécs, in Baranya county in comparison with each other. It is apparent from the summary line that in 2001 we collected about eight times more waste separately in Pécs than in all other settlements of the county. By today, this situation has fortunately changed: in the first table of point 2.2.2.1 it can be seen that 6,324 tons of waste were delivered to the Pécs-Kökény site from separate collection in 2017, of which "only" approx. 3,800 tons come from Pécs, and approx. 2,500 tons come from the rest of the service area, mainly from the settlements of Baranya County.

Separate waste collection data for Baranya County in 2001, broken down by type of settlement:

Waste	Pécs (kg)	Other municipalities (kg)	Total: (kg)
paper	1,850,000	21,800	1,871,800
metal	312,000	114,900	426,900
plastic	175,000	77,000	252,000
glass	118,000	72,000	190,000
organic and green waste	0	0	0
rubber	56,000	22,600	78,600
battery	12,000	2,200	14,200
other dangerous waste	4,000	5,200	9,200
Separate collection total	**2,527,000**	**315,700**	**2,842,700**

2.2.2.2. Mixed residual waste composition data

The total amount of mixed municipal waste and bulky waste accounted for approx. 80% of the quantity generated by the population in 2017, indicating that there are still substantial reserves in the area of separate collection. To further enhance recovery, it is advisable to examine what material streams are currently hidden in mixed collection. This is determined by standard sampling and manual sorting and then weighing. The following tables summarize data from waste analysis conducted recently and around the millennium. The textual evaluation is shown below the last table.

Composition data regarding mixed municipal waste collected in Pécs in 2017:

Name	Distribution (%)					
	1st quarter	2nd quarter	3rd quarter	4th quarter	Average	Corrected average
Biodegradable	**27.34**	**20.89**	**29.63**	**27.08**	**26.24**	**26.20**
Textile	2.67	3.66	2.67	4.10	3.28	3.30
Glass	2.59	4.17	2.03	1.87	2.67	2.60
Sanitary waste	3.15	4.10	3.55	3.91	3.68	3.70
Metal	2.88	4.71	6.45	3.48	4.38	4.40
Plastic	**17.57**	**22.31**	**11.64**	**25.64**	**19.29**	**19.30**
Composite	1.56	4.27	1.51	3.76	2.78	2.80
Cardboard	5.15	4.31	1.41	4.60	3.87	3.90
Non-classified non-combustible waste	2.30	1.94	0.28	1.04	1.39	1.40
Non-classified combustible waste	2.19	2.38	3.47	3.82	2.97	2.90
Paper	10.36	9.01	7.71	7.22	8.58	8.60
Hazardous waste	0.40	0.72	0.27	0.26	0.41	0.40
Waste of small particle size	**21.85**	**17.53**	**29.36**	**13.22**	**20.49**	**20.50**
Total:	100.01	100.00	99.98	100.00		100.00

Source: [11]

Composition data regarding mixed municipal waste collected in Pécs in 2016:

Name	Distribution (%)					
	1st quarter	2nd quarter	3rd quarter	4th quarter	Average	Corrected average
Biodegradable	**29.76**	**27.12**	**36.98**	**31.10**	**31.24**	**31.2**
Textile	2.93	4.20	2.90	3.32	3.34	3.3
Glass	2.92	3.61	3.50	3.32	3.34	3.3
Sanitary waste	2.77	3.60	3.10	3.14	3.15	3.2
Metal	3.26	3.94	3.30	3.48	3.50	3.5
Plastic	**14.49**	**19.40**	**9.59**	**14.40**	**14.47**	**14.5**
Composite	1.89	3.80	2.70	2.78	2.79	2.8
Carton	5.86	3.45	2.50	3.92	3.93	3.9
Non-classified non-combustible waste	2.53	2.22	0.50	2.34	1.90	1.9
Non-classified combustible waste	1.60	1.54	2.30	1.80	1.81	1.8
Paper	11.33	7.34	5.10	7.87	7.91	7.9
Hazardous waste	0.27	0.62	0.60	0.50	0.50	0.5
Waste of small particle size	**20.40**	**19.18**	**26.94**	**22.04**	**22.14**	**22.2**
Total:	100.01	100.02	100.01	100.01	100.01	100

Source: [11]

Composition data regarding mixed municipal waste collected in Pécs and it surroundings from November 2004:

	Sampling locations:					
Type of collection district	Pécs, Panel building	Pécs, inner city	Pécs, Green belt	Rural area, Keszű	Pécs, Industrial-Institutional	
Street / Site	Nagy Imre u.	Király u. and Líceum u.	Pannónia u.	Petőfi u.	Sports hall	
Date	*16.11.2004*	*17.11.2004*	*0*	*0*	*0*	
	TUESDAY	WEDNESDAY	THURSDAY	MONDAY	TUESDAY	
Types of waste (%)	Distribution (%)					***Average***
Bio waste	**32.78**	**32.02**	**40.79**	**41.83**	**15.28**	**32.78**
Papers	**12.11**	**11.79**	**10.2**	**9.25**	**14.26**	**11.47**
Cardboards	**5.76**	**8.3**	**3.47**	**3.09**	**6.05**	**5.28**
Composite	1.73	2.59	1.99	3	10.39	3.9
Textile	2.4	3.2	2.19	2.48	3.39	2.72

Sanitary	4.71	3.74	1.62	2.05	3.29	3.06
Plastics	**17.78**	**14.03**	**11.38**	**12.03**	**19.46**	**14.87**
Combustible	2.5	2.91	2.85	2.5	0.77	2.3
Glass sorts	5.96	5.88	4.62	6.17	13.84	7.25
Metals	2.5	2.16	1.29	2.19	4.22	2.46
Non-combustible	0	0.74	1.72	1.38	1.46	1.06
Hazardous	0.04	0.07	0.04	0.05	0.04	0.05
Fine	**11.73**	**12.5**	**17.83**	**13.96**	**7.53**	**12.77**
Delivery total	100%	100%	100%	100%	100%	100%

Source: [11]

Mixed municipal waste analytical data for Baranya County in 2001, broken down by type of settlement:

Waste	Pécs	Cities	Villages
Paper	17.72%	13.55%	12.77%
Plastic	5.71%	9.47%	8.94%
Metal	4.58%	3.48%	3.64%
Glass	4.44%	3.54%	3.86%
Textile	2.68%	3.07%	1.68%
Inorganic	29.32%	26.58%	28.02%
Mixed organic	35.12%	38.97%	39.74%
Hazardous	0.43%	1.35%	1.35%
Total:	**100%**	**100%**	**100%**

Source: [11]

The most important lessons learned from the above tables are not the types of waste that are most significant but the extent to which the composition varies from one measurement to the other in the same settlement. E.g. in the second quarter of 2016 the proportion of plastics is exactly twice as much as one quarter later (19.40% and 9.59%).

The reasons for volatility may be, for example, changes in the nature of the seasons and of the collection district, but in reality there are dozens of factors that have an influence on composition, which cannot be explicitly shown in the table: precipitation volume/intensity, income position, existence of solid combustion equipment, level of education, standard of environmental education, individual responsibility, packaging material regulation, etc.

In order to be able to give a true characterization of a settlement's or an entire region's waste production habits, waste analyses should be conducted over a long period of time, based on unchanged methodology. In fact, here we face the same the problem, as usual, if we intend to characterize municipal solid waste: how to ensure the representativeness of the sample. Since municipal solid waste is one of the most heterogeneous material groups on Earth, we can rather only use measurement-based approaches in the evaluation.

Despite the selective collection of green waste and home composting, waste subject to mixed collection still contains 25-30% of decomposing organic matter in magnitude, noting that the proportion has seasonally even ranged between 20 to 37% in recent years. The measurements at the beginning of the millennium, however, showed that, depending on a collection district or a partner, this can even move between higher extremes (15% - 42%).

Paper and cardboard factions in Pécs in the early 2000s still accounted for 17%, which decreased to 12% in the past two years.

The proportion of plastic in Pécs increased from the 5.7% value at the millennium to over 14% in 2004 already, and in 2017 it was close to 20%. In view of the door-to-door separate collection and collection by collection islands of plastic waste this indicates that our consumption patterns have changed so that the use and consumption of plastic has significantly increased in proportion.

The small number of waste composition data outside of Pécs does not allow us to make a substantive comparison. Our practical experiences, however, show that the formerly idealized village lifestyle is disappearing: nowadays, more and more villages in the urban areas of cities are also following an urban lifestyle. In everyday life this means, for example, that local food production has decreased, part of the population of villages is only present in the villages for periods of rest, in fact, they work and "consume" in the cities and they buy pre-packaged food in cheap supermarket chains settled in cities, this all resulting in large quantities of plastic and paper packaging materials.

2.3. Croatian public service situation

2.3.1. Area supplied

The City of Osijek is the fourth largest city in Croatia and the centre of the Osijek-Baranja County.

The following settlements are parts of the City of Osijek: Brijest, Briješće, Josipovac, Klisa, Nemetin, Osijek, Podravlje (Jenőfalva), Sarvaš (Drávaszarvas), Tenja, Tvrđavica (Kisdárda), Višnjevac (Rétfalu). This area is approximately 20km long and 5km large.

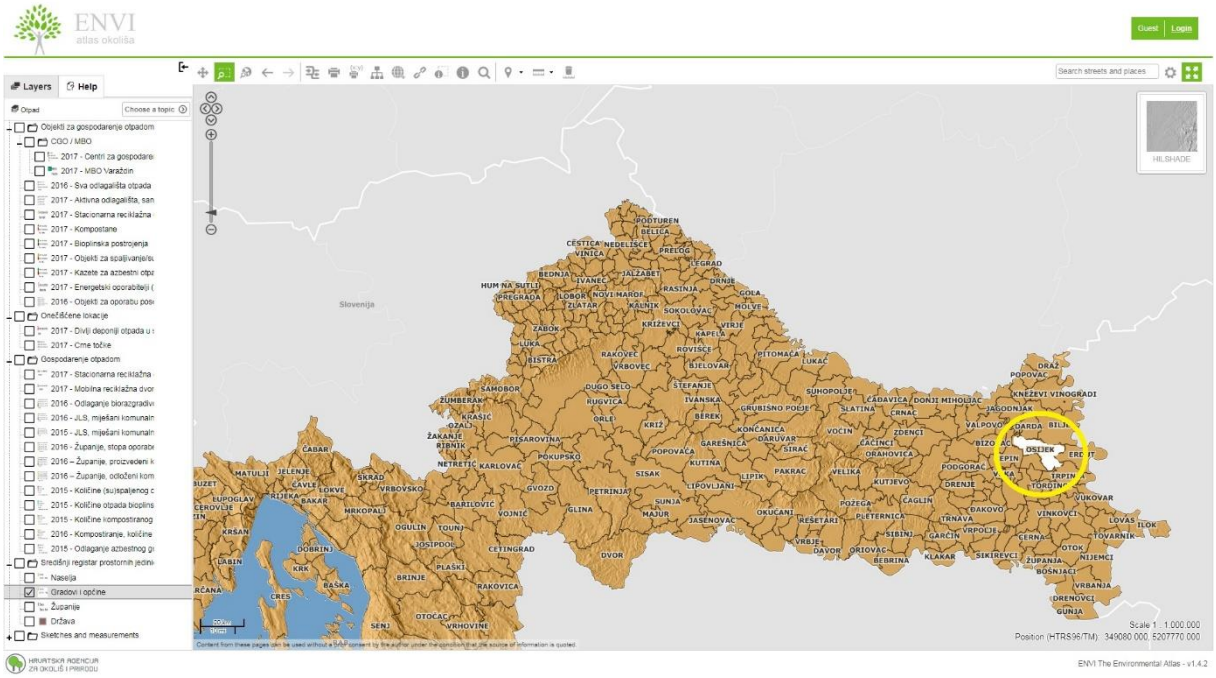
Osijek consists of the old town, Tvrđa, also Gornji Grad, Donji Grad, and Novi Grad (that has two parts Jug I and Jug II), Cvjetno Naselje, as well as Retfala and Industrijska Četvrt.

The population of Osijek itself is 84,104 and the population of the administrative area of the City of Osijek is 108,048.

Unikom d.o.o. for municipal utility management handles the collection of municipal waste in the City of Osijek. Organised collection includes 47,000 homes and 2,000 businesses. Organized waste collection from households is carried out once a week by the following vehicles:

- Compacting garbage truck 8-26 m^3: 11 pieces
- Container truks 5-7 m^3: 7 pieces

Collection area of UNIKOM:

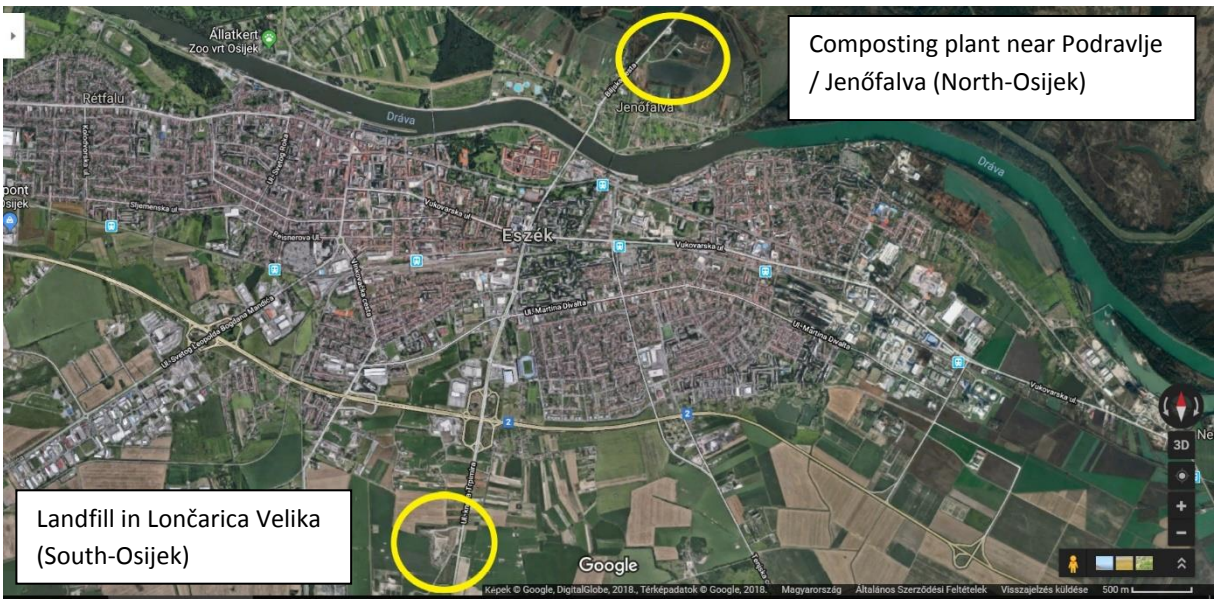


Source: [32]

The total amount of communal waste collected and disposed from homes and services to the waste disposal site Lončarica Velika in 2017 was 23,520 tonnes.

In 2017, a new waste disposal facility has been set up at Loncarica Velika and two more cassettes are being built to accommodate the disposal capacities until construction of the Regional Center that should start operation in 2022.

Landfill and composting plant in Osijek:



Source: [33]

In order to reduce the total amount of waste being disposed to the Lončarica Velika landfill every day, measures are being taken in the City of Osijek to separate usable waste at the location where it is produced, and the former project REGION2SUSTAIN was just one part of a full system for separate waste collection in the City of Osijek. For the purpose of this system, a Study on the Composition of Municipal Waste was performed in 2013, with the following results:

Waste type	**Share (%)**
Paper and cardboard	16.17
Glass	3.03
Plastic	17.58
Metals	1.79
Wood	0.21
biowaste	27.63
Textile	3.00
Soil and stones	0.72
Skin, bones, tires	2.07
Waste smaller than 40 mm	27.80
total:	**100.00**

Based on the composition information, a separate waste collection system was developed.

2.3.2 Measures for Separate Waste Collection

The beginnings of primary selection in the City of Osijek were based on separate collection of usable waste materials through eco islands, which soon turned out to be inefficient because citizens would often place waste around the containers, including the waste that was not intended for the containers, and two dumps were being created in the process, so the initial system for primary selection had to be improved and perfected. Since 2010, separate collection of usable waste materials in Osijek has been organised in several ways:

1. Eco Islands

Across specific locations in the City of Osijek 13 "eco islands" were set up, they include containers for the collection of waste paper, packaging glass, plastic and metal packaging, and textile.

2. Collection of Waste Paper According to the "Door-to-Door" Principle

In 2009 a Pilot Project for the Collection of Waste Paper began in two suburbs Višnjevac and Josipovac. During one year of implementation of this pilot project, 69.04 tonnes of waste paper was collected.

During 2010, organised collection of waste paper began in the City of Osijek according to the "door-to-door" principle. Through this method 170.49 tonnes of waste paper was collected in 2010, and 298.08 tonnes in 2011.

The project for the collection of waste paper according to the "door-to-door" principle continued, 25,000 blue 120l containers were acquired in cooperation with the Environmental Protection and Energy Efficiency Fund, which were used to replace cardboard boxes that were previously used. After the distribution and since the blue containers were put in use the quantity of collected paper increased significantly, and 1287.94 tonnes of paper was collected in 2012, which is an increase of about 300% when compared to the same period during 2011, and 1,515.54 tonnes was collected in 2013. The amount of waste paper collected in 2014 was 1480.51 tonnes; we believe that this slight drop in quantity is due to the new waste paper collectors that appeared in the City of Osijek. The amount of collected waste paper in 2017 is 1,754 tonnes.

3. Collection of Plastics According to the "Door-to-Door" Principle

In April of 2013 the system of selective collection of useful waste from citizens according to the "door-to-door" principle expanded to plastics. Yellow 80l and 120l PVC bags for selective

collection of plastics were distributed to citizens. The amount of plastics collected in 2013 was 111.74 tonnes.

In 2014, as part of the IPA cross-border cooperation project Croatia-Serbia titled "The Case for Zero Waste", 1,300 containers for collecting plastics in large residential buildings were acquired. All the buildings in the City of Osijek received their containers in which the citizens could deposit their plastics. The amount of plastics collected in 2014 was 358.90 tonnes, and 639 tonnes was collected in 2017.

4. Pilot Project for Primary Selection in Large Residential Buildings "Recycle in Slippers"

In 2014 the Pilot Project for Primary Selection in Large Residential Buildings began in the section of the City called Sjenjak. As part of this project, so called nests with containers for separate waste collection were placed in eight buildings with 100 and more flats. This way the citizens were provided with full opportunity to separate waste in the location where it was created. A blue container for separate collection of paper and a metal stand with a yellow PVC bag for collecting plastics were placed on floors in every building included in this pilot project. One container for the collection of metal packaging and one container for collecting glass, as well as containers for collecting pharmaceuticals and batteries, one of each, were placed in the rooms used for the collection of municipal waste.

5. Recycling Yards

There are three recycling yards currently available to citizens in the City of Osijek. Since 2010, a recycling yard is available to the citizens as part of the municipal waste disposal site Lončarica Velika, also the recycling yard Zeleni Otok was built during 2011. So, along with the existing recycling yard in the J. J. Strossmayer Street, the City of Osijek has three recycling yards at the moment.

6. Eco Points

During 2011, as part of the IPA project Croatia-Serbia, five eco points were set up in the City of Osijek and the City of Subotica.

Eco points were placed in five locations in the City of Osijek in parts of the city with large residential buildings, and they represent one additional way used to try to provide the citizens with a space near their home where they can deposit usable waste.

7. Mini Eco Islands

Mini eco Islands were acquired as part of the IPA cross-border cooperation project Croatia-Serbia, titled "The Case for Zero Waste". Mini eco islands were placed in 20 locations in the City of Osijek where a large number of people circulate so they could separate waste in the

location where it was created. It is possible to deposit paper, plastics, metal packaging, and bio waste in the mini eco islands.
Placing these mini eco islands contributed to the development of municipal infrastructure in the City of Osijek and the successful implementation of the primary selection system continued. The mini eco islands that were set up were the first islands of this type in the Republic of Croatia. These types of containers for separate waste collection were installed for the 2012 Summer Olympics in London the first time, so Osijek is, along with London, one of the rare European cities to have the most modern municipal equipment for separate waste collection.

Separately collected recoverable waste is submitted to an authorized repository that further sorts and sells it on the stock exchange.

8. Collection of Biological Waste

Separate collection of biological waste in the City of Osijek begins in the spring of 2016 through a pilot project as part of the IPA Project REGION2SUSTAIN Cross-Border Cooperation Croatia – Hungary. Beneficiaries who live in family houses will receive composters for individual composting. Beneficiaries in large residential buildings will receive a 16l biological waste container for every flat in which they can deposit their kitchen waste, and empty it in a brown biological waste container which will be in the common room in the building. The collected biological waste will be transported to further processing, i.e. composting at the newly built compost facility. The construction of the compost facility on Bilje Road (NE from Podravlje / Jenőfalva) is significant for the management of biological waste from households and public green spaces, which will ultimately reduce the amount of municipal waste deposited at the waste disposal site Lončarica Velika.
Construction of the composting facility began in 2015. All preliminary works, earthworks, and road construction have been completed. Forming the first compost piles is planned for May of 2016.
By developing the door-to-door system, the amount of mixed municipal waste is decreasing every year.

Distribution of wastes collected in Osijek city in 2017

Waste type	Amount collected (kg)	Share (%)	waste collected per capita (kg)	waste collected per household (kg)
Mixed MSW	**23,520,000**	**81.3%**	**218**	**500**
Bio waste	2900000	10.0%	27	62
Paper	1,754,300	6.1%	16	37
Glass	28390	0.1%	0	1
PET	638270	2.2%	6	14
WEEE	65400	0.2%	1	1
Plastic film	15,420	0.1%	0	0
Medicine	100	0.0%	0	0
Metals	4,340	0.0%	0	0
Batteries	1020	0.0%	0	0
Fluorescent tubes	120	0.0%	0	0
Lubricating oil	2370	0.0%	0	0
Sub-total recyclable	**5409730**	**18.7%**	**50**	**115**
Total waste collected	**28,929,730**	**100.0%**	**268**	**616**

Demographic data used to calculate specific indicators in Osijek:

Population (persons)	108,048
Households (pcs)	47,000
Average number of persons in household	2.3

The percentage distribution of wastes collected in Osijek is very similar to that of Pécs: the proportion of the separate collection of recoverable materials is nearly 20%, half of which is organic waste, and the total quantities collected per capita also show a consistency within the within the margin of error.

The comparison of paper and plastic waste streams with the highest mass among separately collected wastes is not possible because of the “Separate mixed (paper, plastic, metal) waste collection” in operation in Pécs, because the internal distribution of this waste stream is unknown.

2.3.3. Finances

Tarifs

Unikom, as a public service provider, calculates for the user a collection price for the mixed and biodegradable municipal waste, in proportion to the quantity of collected waste in one accounting period. Criterion of waste amount in the accounting period is the volume of waste bin / container and the number of emptying. The bill is paid by the citizens.

Investments

The City of Osijek, along with the municipal company Unikom, invested significant funds for the improvement of municipal infrastructure and the development of the primary selection system. In the period 2010 – 2015, 25,000 blue containers for collecting paper were distributed to the citizens and 1,300 yellow containers were distributed to the citizens who live in large residential buildings. We are the only city in Croatia that enabled their citizens who live in buildings with 100 and more flats to separate waste on their doorstep, through the project "Recycle in Slippers". Along with three recycling yards where citizens may bring their separated waste, 13 eco islands, 20 mini eco islands, and 5 eco points were set up in the City of Osijek.

In 2016 Osijek started with separate collection of biological waste, which will be deposited at the newly build compost facility, and we distributed 500 composters for individual composting to beneficiaries who live in family houses.

Systematic education of all social groups in the City of Osijek is very important, so for that purpose the Ecology-Education Centre was built as part of the recycling yard in Jug II.

In the period 2010 – 2015, HRK 25,462,379.36 (about € 3,300,000) was invested in the development of the primary waste selection system.

In the period 2016 – 2020, the plan is to continue with the construction of the compost facility, and the acquisition of more machinery and equipment for biological waste management in the City of Osijek, in order to completely implement the system for separate collection and management of biological waste. The planned investment is HRK 27,705,038.97 (about € 3,600,000).

2.3.4. Education

Since 2006 the company Unikom d.o.o. is conducting systematic education of children regarding selection, utilisation, and management of waste, in kindergartens and elementary and secondary schools in Osijek, by implementing educational workshops throughout the school year.

The education cycle ends as the school year finishes, with a significant project commemorating Earth Day (April 22).

As part of the education, Unikom is trying to emphasize the importance of environmental protection and acting according to natural laws, and environmental education is more efficient if it starts early in life.

Aside from schools, Unikom has been intensively cooperating with ecological associations that operate in the City of Osijek, those are: Association for Nature and Environment Protection Green Osijek, Friends of the Environment – Osijek, Compost Centre.

All of the ecological activities have good media coverage. Unikom participated in local television's special programmes that broadcasted news, as well as coverage of our Earth Day commemoration. This way, the company made the wider public aware of its work in education for children.

3. Recommendations for Development and Cooperation

3.1 Development options in Hungary

In making the waste management infrastructure operated by the BIOKOM Group more efficient, we pursue two closely related goals: reducing dumping of waste and increasing the yield of recycled materials.
The three pillars of this are:

1. To maximize yields from waste-derived secondary fuel (RDF-residue derived fuel, or SRF-solid recovered fuel), as of the fractions that can be produced from mixed waste, this is the only one that represents high volumes and is industrially exploitable.
2. To maximize yields of secondary raw material of separately collected packaging material waste in manual sorting plants.
3. To maximize the segregated collection and recovery of organic waste.

Below, these three main development concepts are described.

3.1.1. Quality improvement of secondary fuels derived from waste and quantitative increase in yields

The part of the municipal solid waste subject to mixed collection and recoverable in the form of energy recovery is the so-called “light fraction”, which mainly contains plastics in addition to paper and textiles, which, due to its low density, occupies an extremely large volume, and is therefore of critical importance for landfill life. The further fate of the light fraction is essentially determined by the quality of the mixture of substances that can be produced in the mechanical-biological treatment plants: below a certain calorific value, and over a certain moisture and pollutant content neither the cement factories nor the power plants will receive it, so according to the worst case scenario they will be dumped. A further problem is that, while the quality of incoming waste varies over time, the demand side expects fuel homogeneous in space and time.
Therefore, the focus of further development is to improve the qualitative and quantitative parameters of secondary fuels suitable for energy recovery:
1. Increase of calorific value

- Identifying factors affecting moisture content and their impact, intervening at technology, logistics and other levels.

- Improving fuel composition (enhancing enrichment) by increasing the separation efficiency of non-combustible (inert) and wet bio-waste.

2. Quality improvement

- Subsequent reduction of chlorine, thallium, cadmium and other undesirable foreign matter content by technological means
- Exploration of the deterministic relationship between the composition of the input material stream and the quality of the fuel. Interventions to change composition:
    - optimization of separate collection of packaging materials and organic waste (while taking into account the minimum requirements of material recovery in line with energy recovery);
    - pre-sorting by human-controlled machine prior to dispatch to the technology line;
    - detecting and automated removal of large pieces of metal as foreign matter in a large metal frame environment (on pre-crushing and belt feeder equipment).

3. Increase of yield

- Increasing the efficiency of separation of combustible and non-combustible waste (inert, heavy fraction). Currently there is a large amount of combustible material in the heavy fraction (e.g. sticky wet plastic, or substances heavy in themselves but highly combustible).
- Improvement of metal deposition efficiency
- Improvement of organic waste separation efficiency
- Selection of combustible fractions from biologically treated waste (bio-stabilate) - mainly plastic waste.

3.1.2. Development of secondary raw material production in material recovery facilities

In the last 10-15 years, approx. 40 waste sorting plants were built in Hungary, typically with EU funding. All the plants built between 2000 and 2015 use manual sorting, which corresponds to the best available technological level at that time. Given the volume of investment costs and the length of the real (non-accounting) depreciation period, these sorting plants will operate for at least another 10-20 years, and there are no sufficient resources available to construct more advanced plants.

During operation, we had to be faced with the fact that during the selection of waste from residential separate collection efficiency is 8 to 10 times worse than in the case of industrial separate collection. This causes in part capacity related problems and in part problems related to profitability. The reason for this phenomenon is that the separately collected waste

removed from households has different characteristics, that is, it contains a much wider variety of material types and a significantly larger proportion of foreign matter than the packaging materials produced by industrial operators.
Developments will therefore be directed towards introducing a machine pre-selection process after which manual selection will only play a quality enhancing role.
1. Compliance with the requirements of automatic processing

- Improvement of the homogenization of waste
- Compliance with the requirements of the preparation for future technological processes, dosage
- Efficient separation of materially recoverable and other waste streams

2. Separation processes according to material and colour

- segregation 2D and 3D substances
- Use of infrared technologies for separation according to material and/or colour

3.1.3. Maximizing the segregated collection and recovery of organic waste

It can be seen from the waste analysis data contained in point 2.2.2 that mixed waste still contains 25-30 m/m% of decomposing organic matter, although 4.5 + 4.5 thousand tons of organic waste is delivered from the households and institutions to the Pécs-Kökény compost site. The most significant problem with this waste stream is that it cannot be regarded as compost after biological treatment due to mixed collection, it cannot be marketed and cannot be used as soil conditioner (see description at end of point 2.2.2). As a result, the treated organic waste is deposited as stabilate at the landfill.
To minimize this, firstly, the developments concerning the collection system indicated in points 4.3.2.1 and 4.3.2.2 are required, and also the treatment itself requires further infrastructure interventions as the Pécs-Kökény Compost Plant operates at the limit of the authorized capacity.
From the point of view of developments, it is worth considering the fact that a biogas plant treating waste water sludge is already in operation West of Pécs, which would be able to receive additional raw materials beyond the amount currently processed. Similar to the regional waste treatment centre in operation in Treviso (Italy), it would be technically possible to press the collected bio-waste, to compost the dry fraction at the Pécs-Kökény site and to process the extracted liquid in a wet technology biogas plant.
By this cooperation the construction of a dry fermentation biogas plant for the treatment of the organic fraction of municipal solid waste can be avoided, while some of its energy content can be extracted. This solution would be more beneficial also environmentally, as during

aerobic and anaerobic degradation the energy and material balance of transformation is quite different; for soil improvement, aerobic treatment (composting) results in a better end product than the anaerobic process.

3.2 Development options in Croatia

This chapter briefly presents the development plans officially approved at government level, along with the technical design methodology and the options for logistical and financial changes inspired by the field trip organised under the 2Regions2Sustain project.

3.2.1. Official plans

The Republic of Croatia plans to build 11 Regional Waste Management Centers.

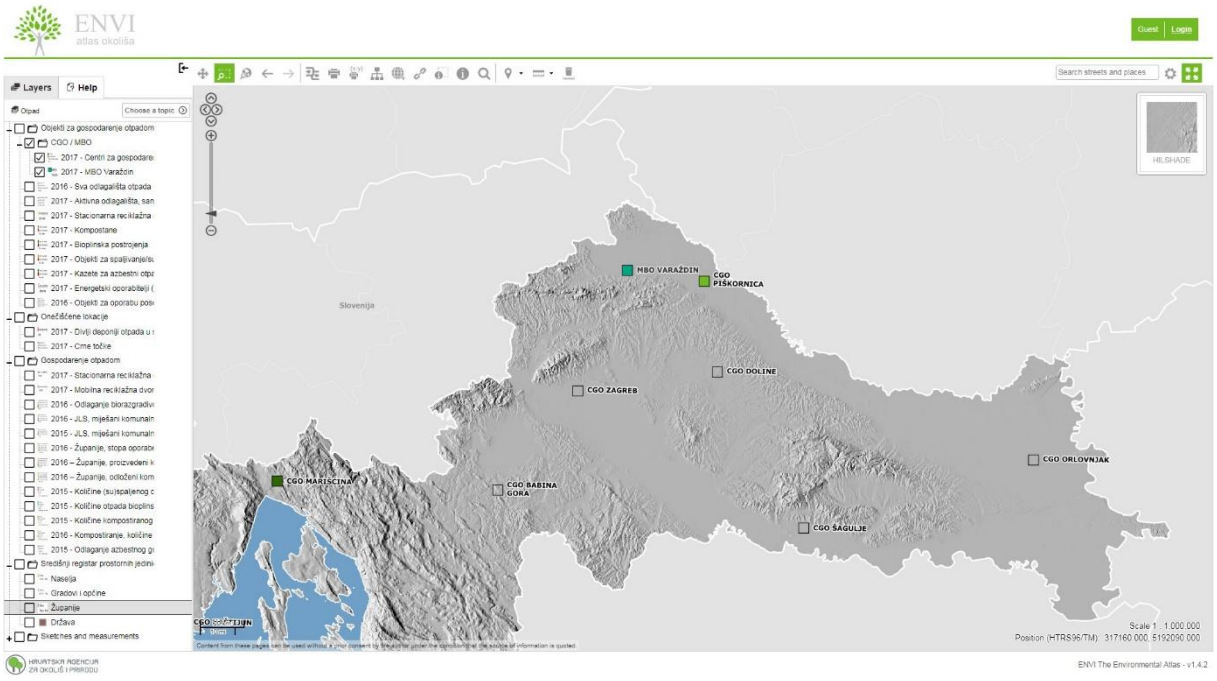


Image: some of the planned waste management centres in Croatia [32]

One of them is the **Regional Waste Management Center Orlovnjak near Osijek**, which covers the entire area of Osijek-Baranja County (seven cities and 35 municipalities, totaling 305,032 inhabitants), Vukovar-Srijem County (five cities and 26 municipalities, totaling 180,117 inhabitants) , as well as the bordering parts of Brodsko-Posavska, Požeško-Slavonska and Virovitica-Podravina County (one city and nine municipalities, totaling 28,597 inhabitants). With the opening of the Center, landfill of Lončarica Velika, which is currently disposing the waste from the area of Osijek, is terminated.

By building **a regional management center** mixed communal waste will be forwarded to the center for **further processing**.

The plant will hopefully start operating in 2022.

3.2.2. Methodological considerations regarding the establishment of a regional waste treatment centre

BIOKOM Nonprofit Ltd. has already participated in the logistics and technological planning of several regional waste management systems and operates such an infrastructure. To share design expertise, the most important preventive tests are presented below.

The essence of our design concept was on the one hand for the system to deliver the highest possible number and the best quality of secondary raw materials or fuel, and on the other hand to also ensure flexibility to allow for the operator to produce materials of different qualities and of different levels of processing by adapting to various market conditions and legislative circumstances.

Due to the prevalence of mixed collection, the processing of mixed household waste of EWC code 20 03 01 became the most important element of the system, and for this we were looking for a technological line capable of qualitative separation based on quantitative parameters (e.g. particle size). To do this, we had to know what types of wastes were actually present and in which size range in the mixed waste.

The following tables show the results of a much more detailed analysis of waste than standard.

Material composition of sieve fractions

Particle size, mm	Mass fraction [%]	Organic [%]	Paper [%]	Plastic [%]	Ferrous [%]	Non-ferrous [%]	Glass [%]	Non-combustible [%]	Combustible [%]	Textile [%]	Composite [%]	Cardboard [%]	Sanitary [%]	Hazardous [%]	Total [%]
> 200	4.68	9.16	0.96	37.11	0.00	2.17	0.00	0.00	0.00	35.42	0.00	15.18	0.00	0.00	100.00
150…200	5.25	7.71	24.53	32.94	3.27	1.64	0.00	0.00	0.93	10.757	0.93	9.58	4.44	3.27	100.00
120…150	6.97	8.14	25.08	35.93	0.00	2.03	0.00	0.00	0.00	8.81	9.83	4.75	5.42	0.00	100.00
100…120	17.02	11.25	14.24	29.31	5.83	2.92	10.56	0.76	2.43	2.64	0.56	3.06	10.69	5.76	100.00
90…100	2.67	9.26	19.44	29.63	0.00	7.41	0.00	0.00	2.78	5.56	1.85	2.78	21.30	0.00	100.00
75…90	9.98	7.18	23.02	17.57	6.93	5.20	8.17	1.24	4.21	1.73	2.72	3.47	18.07	0.49	100.00
50…75	8.68	35.37	19.92	11.79	5.28	5.28	10.57	1.22	4.88	0.81	1.22	2.03	1.22	0.41	100.00
40…50	10.15	25.00	17.86	14.29	7.14	7.14	17.86	10.71	0.00	0.00	0.00	0.00	0.00	0.00	100.00
30…40	2.42	27.78	16.67	5.56	2.78	2.78	27.78	8.33	5.56	0.00	0.00	0.00	0.00	2.78	100.00
20…30	6.73	74.26	3.96	1.98	0.99	0.99	8.91	6.93	1.98	0.00	0.00	0.00	0.00	0.00	100.00
0…20	25.47	93.59	0.00	6.15	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Σ	100.00														

The above table should first be read horizontally, each line individually, so it is possible to see the proportion of individual waste types within the given particle size range. The only exception is the mass fraction column, indicating what percentage within the total sampled waste can be found in the individual particle size ranges.

Distribution of material components of sieve fractions

Grain size, mm	Mass fraction [%]	Organic [%]	Paper [%]	Plastic [%]	Ferrous [%]	Non-ferrous [%]	Glass [%]	Non-combustible [%]	Combustible [%]	Textile [%]	Composite [%]	Cardboard [%]	Sanitary [%]	Hazardous [%]
> 200	4.68	1.09	0.36	9.75	0.00	3.47	0.00	0.00	0.00	45.07	0.00	26.70	0.00	0.00
150…200	5.25	1.03	10.27	9.71	5.41	2.93	0.00	0.00	2.98	15.34	3.90	18.90	4.75	13.16
120…150	6.97	1.44	13.96	14.07	0.00	4.85	0.00	0.00	0.00	16.72	54.58	12.44	7.71	0.00
100…120	17.02	4.86	19.34	28.01	31.29	16.97	27.17	6.15	25.11	12.22	7.53	19.55	37.09	75.21
90…100	2.67	0.63	4.14	4.44	0.00	6.76	0.00	0.00	4.50	4.03	3.93	2.79	11.57	0.00
75…90	9.98	1.82	18.33	9.85	21.79	17.73	12.33	5.84	25.49	4.70	21.63	13.00	36.73	3.79
50…75	8.68	7.79	13.79	5.74	14.45	15.68	13.87	5.00	25.70	1.92	8.43	6.63	2.16	2.70
40…50	10.15	6.44	14.47	8.14	22.85	24.80	27.42	51.44	0.00	0.00	0.00	0.00	0.00	0.00
30…40	2.42	1.70	3.21	0.75	2.11	2.29	10.15	9.52	8.15	0.00	0.00	0.00	0.00	5.14
20…30	6.73	12.68	2.13	0.75	2.10	2.28	9.06	22.05	8.08	0.00	0.00	0.00	0.00	0.00
0…20	25.47	60.52	0.00	8.80	0.00	2.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Σ	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.0	100.00	100.0

Contrary to the previous one, this table should always be read in the vertical direction: within the type of waste (e.g. paper) intended to be tested it can be seen what percentage thereof can be found in the individual particle size range. The mass fraction column is identical with that of the previous table.

Cumulative distribution of material components of sieve fractions

Particle size, mm	Mass fraction [%]	Organic [%]	Paper [%]	Plastic [%]	Ferrous [%]	Non-ferrous [%]	Glass [%]	Non-combustible [%]	Combustible [%]	Textile [%]	Composite [%]	Cardboard [%]	Sanitary [%]	Hazardous [%]
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	25.47	60.52	0.00	8.80	0.00	2.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	32.19	73.20	2.13	9.55	2.10	4.51	9.06	22.05	8.08	0.00	0.00	0.00	0.00	0.00
40	34.61	74.90	5.34	10.30	4.21	6.81	19.21	31.57	16.23	0.00	0.00	0.00	0.00	5.15
50	44.76	81.35	19.81	18.44	27.06	31.60	46.63	83.01	16.23	0.00	0.00	0.00	0.00	5.15
75	53.44	89.14	33.60	24.19	41.51	47.28	60.50	88.01	41.93	1.92	8.43	6.63	2.16	7.85
90	63.41	90.96	51.93	34.03	63.31	65.02	72.83	93.85	67.41	6.62	30.05	19.63	38.89	11.64

100	66.08	91.58	56.07	38.47	63.31	71.77	72.83	93.85	71.91	10.65	33.99	22.41	50.46	11.64
120	83.10	96.45	75.41	66.48	94.59	88.75	100.00	100.00	97.02	22.87	41.51	41.96	87.55	86.84
150	90.08	97.89	89.37	80.55	94.59	93.60	100.00	100.00	97.02	39.59	96.10	54.41	95.25	86.84
200	95.32	98.91	99.64	90.25	100.00	96.53	100.00	100.00	100.00	54.93	100.00	73.30	100.00	100.00
>200	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The table containing the cumulative data should be read vertically just like in the previous one, but here, by moving from the smallest to the largest particle size, it is shown in aggregate, what proportion of the examined type of waste can be found aggregated from zero to the specific particle size. For example, in the 40 mm line, the elementary data of the ranges of 0 ... 20 + 20 ... 30 + 30 ... 40 mm of the previous table are shown in aggregated form.

From the data of the above table we obtain the following two distribution charts:

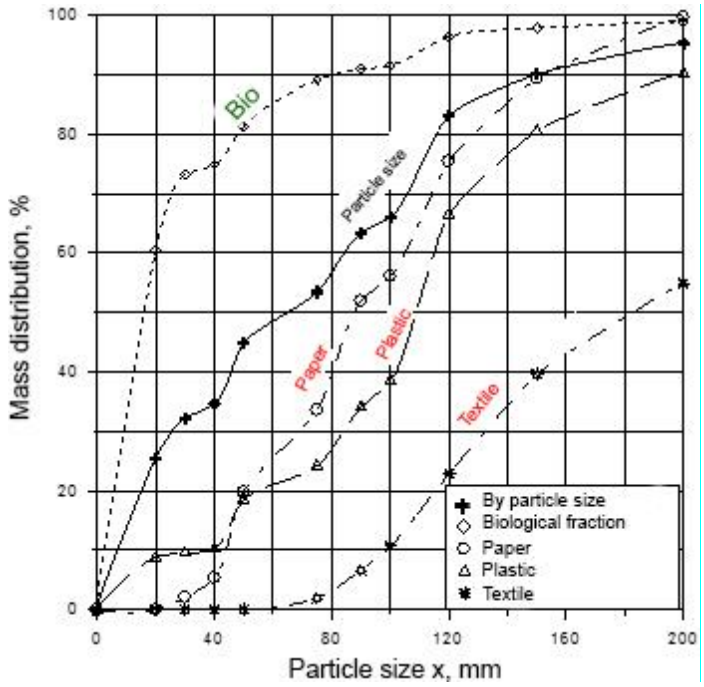


Figure: Distribution of the main components of the raw waste sample by particle size

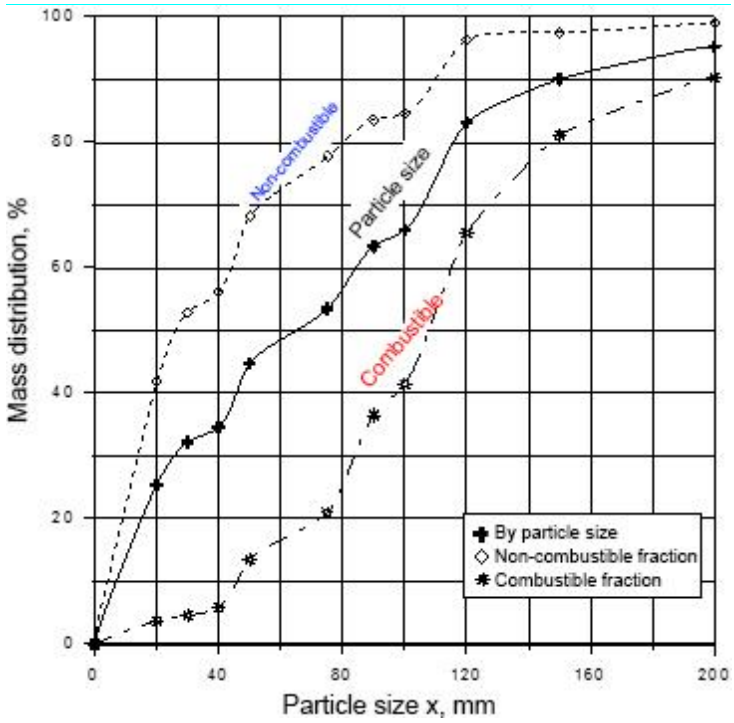


Figure: Joint distribution of the combustible and non-combustible components of the raw waste sample by particle size

It is important to note that the diagram shows that combustible and non-combustible fractions do not match the wastes of the same names of the table: in the diagram, the non-combustible fraction contains, for example, bio-waste, metal, glass, etc., and the combustible ones include plastic, paper, cardboard, textiles, etc.

When examining the distribution of material components according to particle size it can be observed that:

- 80% of the biodegradable fraction is in the <50 mm particle fraction, whereas 80% of paper and plastics are in the particle size set of >50 mm.
- Approximately 80% of all non-combustible materials can be found in the <75...80 mm particle fraction, whereas 80% of the combustible material group is enriched in the coarser > 80 mm particle size.

After analyzing and interpreting the data, a technological proposal can be formulated that follows the Pareto principle to ensure that by separating the mixed waste stream by purely particle size, and with low contamination we can produce combustible fractions of organic decomposition or high calorific value. This practically means that separation can be ensured by a drum sieve of 50 to 60 mm granular size. Of course, the technology has to incorporate metal and other inert fraction separation equipment as well. We emphasize that this

separation dimension limit was applicable to the material stream for which the detailed analysis was performed. Adapting this method can only be imagined by performing this detailed analysis of waste in the design region as well.

3.2.3 Developments inspired by the field trip

The study trip in Italy generated the following new ideas:

Good practice examples from cities we visited during this study trip will certainly be applicable to waste management system in the city of Osijek.

- As an example of good practice, **EKO BUS** operated by the utility company Contarina from Treviso to collect selected waste in remote parts of the city (see more detail under 4.3.2.2.).
- Organization of a **system for collecting bio-waste in individual housing through smaller vessels of 30l** and **refining on trucks for easier discharge of these vessels** is one of the good ideas that can be used in the organization of bio-collection in Osijek, as well as the system of **warning and payment of penalties for irresponsible citizens**.
- Milan City's experience in **establishing a real time information system** will certainly be useful to implement in Osijek's container and user records system.

3.3. Cooperation options

Concerning cross-border waste management cooperation, it is unavoidable to obtain a clear picture of which types of waste can cross the country's borders.

3.3.1. Regulation of international shipments of waste

Regulation (EC) No. 1013/2006 of the European Parliament and of the Council regulated shipments of waste within and outside of the EU (export and import), as well as between EU Member States with transit through third countries. The regulation does not apply to radioactive waste, the shipment of which is regulated in a separate regulation. Shipment of a part of wastes involves only an information requirement (green listed waste), whereas the shipment of other parts is subject to prior notification (amber listed waste) and authorization. In the latter case, the authorities of the origin, transit and destination countries must consent to the shipment. Where the authorised shipment or the planned recovery or disposal cannot be realised for whatever reason (e.g. the waste was mixed with other waste prior to shipment), a take-back obligation must be enforced, i.e. the entity that had the shipment

carried out must take back the waste at its own expense. During shipment the principle of proximity shall be enforced, whereby recovery or disposal of waste should be carried out at the closest possible adequate facility. Additionally, the principle of self-sufficiency should also be considered whereby the target is full disposal of wastes generated which should be achieved by a disposal network. The regulation also contains a list of wastes that are subject to prohibition of exports.

Green list wastes consist essentially of non-blended material streams intended for recovery, which do not contain hazardous substances. These include for example:

- metals,
- electric and electronic wastes,
- plastics,
- paper,
- textile,
- rubber tyres,
- wood waste

The detailed rules are set out in Annex III to the Regulation, referring to Annex IX of the Basel Convention, however, the **exact waste list** is included in **Annex V, Part 1, List B** of that same Regulation, to include **all wastes listed in Annex V, Part 2, which are not considered to be hazardous**. The latter means, in fact, all the items of the complete waste list in contained Decision 2000/532/EC which are not marked by the hazard symbol (*).

Wastes primarily transported across the border for disposal purposes and/or classifying as hazardous waste are placed on the yellow list, and therefore are subject to notification and license application.
These include for example:

- toxic metals (heavy metals),
- asbestos
- waste oil,
- household waste (EWC 20 03 01).

The detailed rules are set out in Annex IV to the Regulation, referring to Annexes II, VIII and IX/A of the Basel Convention, however, the **exact waste list** is included in **Annex V, Part 1, List A** of that same Regulation, also to include **all wastes listed in Annex V, Part 2, which are considered to be hazardous,** as well as those listed in **Annex V, Part 3**. The items contained in Annex V Part 2, in fact, represent all the items of the complete waste list in contained Decision 2000/532/EC which are marked by the hazard symbol (*).

Wastes collected from households are mentioned, specifically highlighted from the above, separately in Annex V Part 3 of the Regulation, and thus they are included in the yellow list, with the remark that “Unless it can be properly classified in the single line of Annex III”. The chances of applying this exception are negligible given the extremely heterogeneous nature of household wastes.

The Regulation was slightly amended by Regulation (EC) No 660/2004 of the European Parliament and of the Council, but it did not affect the green and yellow lists. [34] [27]

3.3.2 Options for cooperation on the two sides of the border

As mentioned in the previous point, waste types collected separately, suitable for recovery can be considered for cross-border traffic if there is an appropriate recovery facility for the specific waste stream across the border.

The following map shows the recovery plants located near the border:

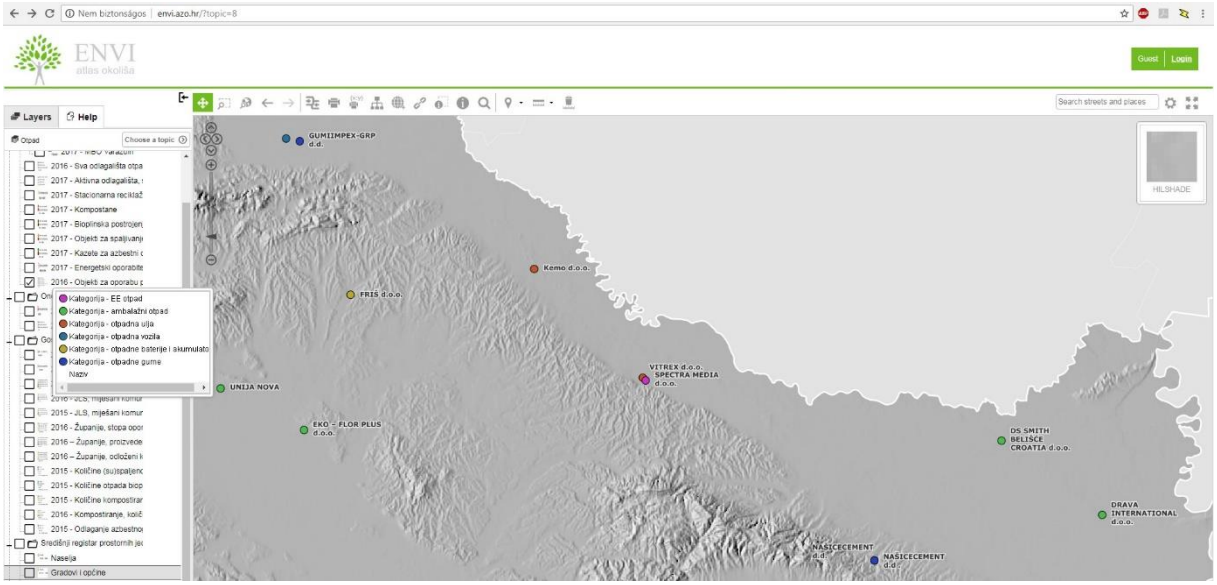


Figure: recovery plants, on the left with colour code [32]

The cement works at Nasice are owned by the Nexe Group, their subsidiary Ekonex d.o.o. is engaged in the procurement of alternative raw materials and fuels. Currently they can receive rubber tyres and waste oil.

On the northern side of the border, the Beremend and the Királyegyház cement works are prepared for the recovery of both used tyres and for energy recovery of waste recovered fuel (SRF). The recovery of SRF in Hungary for Osijek and its region can only become reality if the

regional treatment centre, expected by 2022, will be built and it will have a suitable mechanical sorting facility for the decomposition of mixed municipal waste into fractions.

DRAVA INTERNATIONAL d.o.o. is engaged in the production of plastic products, so it could be suitable for the processing of separately collected and sorted plastic secondary raw materials.

DS Smith Paper Factory in Belize could be able to process separately collected and sorted paper and cardboard secondary raw materials.

Spectra Media d.o.o., located in Virovitica, processes electrical and electronic waste. At the same settlement, Vitrex d.o.o. produces bio diesel from used cooking oil.

The possibility of exporting from Hungary is made more difficult by the fact that while in the past the waste collecting and pre-processing company used to be the owner of waste, nowadays, as a result of changes in legislation, the state waste management company, NHKV can exercise ownership rights. In basic terms, this means that the secondary raw material produced by BIOKOM or the fuel derived from waste cannot be sold by BIOKOM either domestically or abroad.

From the above it can be seen that there are moderate utilization capacities near the border, but due to the lack of pre-processing infrastructure on the Croatian side, and due to the ownership issue on the Hungarian side, the current cross-border waste movement is very limited.
At the same time, we do not have to face this kind of difficulty when we are basically seeking to share information:

- It would be useful to conduct regular consultations between the waste management public utilities of the Osijek and Pécs region, in the course of which changes in the market and the legislative situation, as well as technological, logistics and knowledge-forming experiences could be shared.
- Consideration should also be given to the creation and use of an on-line secondary raw material marketplace that would allow for the matching of the supply and demand side on both sides of the border.

4. Opportunities for the Creation of Green Jobs

Prior to outlining job creation opportunities related to waste management it is worthwhile to review the labour market situation and tendencies as both bordering regions have suffered significant population loss since joining the EU. Both domestic migration and migration abroad have reached alarming proportions to the degree of social reproduction, so we need to examine which segments of the population may benefit from job creation.

4.1. Labour market situation in Baranya

The table below summarises the labour market indicators for Baranya in the first half of 2018:

Indicator	Baranya
Population (thousand)	363.7
Active aged (15-64) population (thousand)	276.1
Economically active population (thousand)	171.6
Working population (thousand)	159.0
Employment rate (%)	57.6
Number of unemployed (KSH, ILO) (thousand)	13.6
Number of persons employed (thousand)	85.9
Inactive population (thousand)	104.5

Source: [35]

The employment rate in Baranya increased by 9.8% points between 2010 and 2018, the number of unemployed persons decreased by half.

According to the employment service, in June 2018 the number of persons seeking jobs was 13,651, with the following territorial distribution:

District	Number of jobseekers
Pécs	4,201
Siklós	2,344
Szigetvár	1701
Mohács	1305
Sellye	1076
Komló	972
Hegyhát	745
Szentlőrinc	650
Bóly	350
Pécsvárad	259
Baranya	**13,651**

Thanks to the different economic capabilities of the various districts of the county, significant differences are present: whereas in the county seat the number of jobseekers is the same as the national average (3.3% of employment age (15-64) population), in Sellye this figure is three times higher (10.4%).

17.1% of jobseekers in the county are under the age of 25, 31.4% are over fifty, the division between sexes is well balanced (49.9% male and 50.1% female).

Almost half of those on record have completed at most elementary school (this is the same as the national figure). There are significant differences between the various districts in this respect as well (in Pécs merely one-third, while in the Hegyhát District three quarters have the lowest education level). [35]

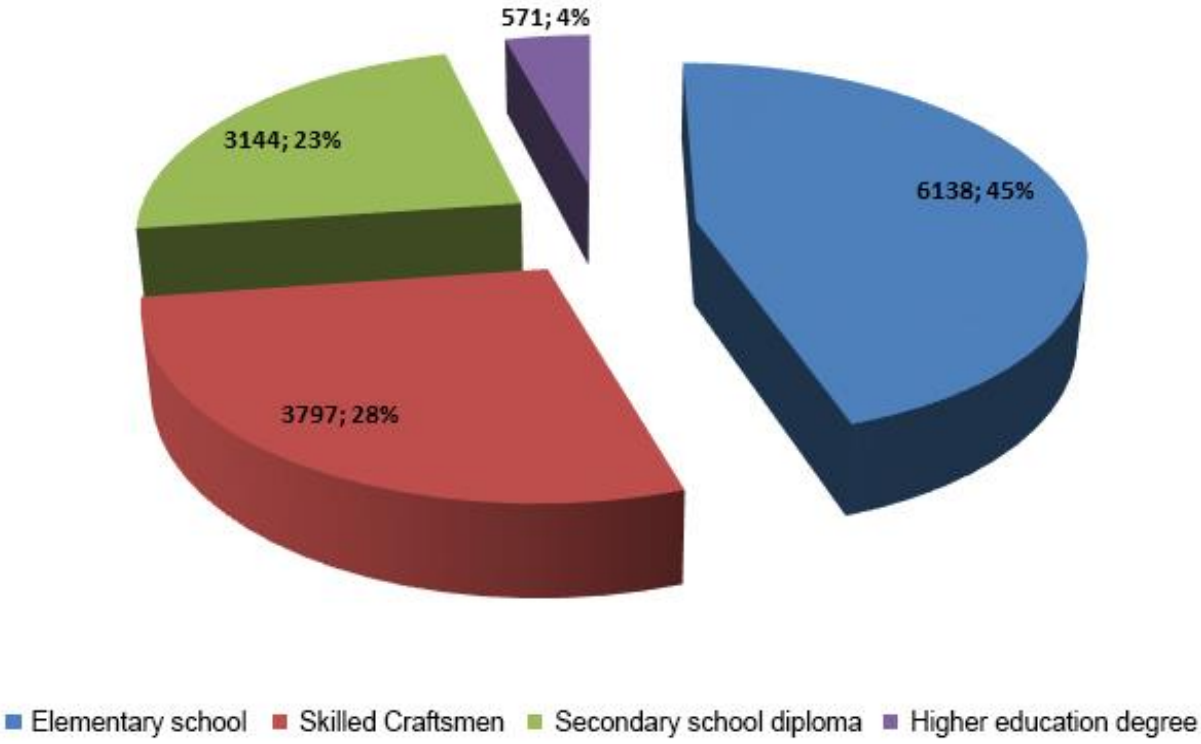


Figure: Composition of registered jobseekers by education level [35]

In Baranya, the proportion of those participating in the public works scheme among registered jobseekers is 40.8%, i.e. there are four public workers for six registered jobseekers (this is similar to the national ratio). This figure is 27.1% in the county seat, i.e. one public worker for three registered persons (this is a good ratio compared to the national average), at the same time, in Sellye the number of public workers is one and a half times higher than the number of registered jobseekers (there are six public workers for four registered persons).

Name of District	Number of persons participating in public works scheme
Szigetvár	1764
Pécs	1563
Sellye	1467
Siklós	1313
Komló	949
Mohács	806
Hegyhát	563

Szentlőrinc	538
Pécsvárad	268
Bóly	164
Baranya	9,394
South-Transdanubia	18,556
Hungary	148,024

Table: Number of persons participating in public works scheme per district[35]

In Szigetvár, which has a much smaller population than Pécs, the number of persons participating in the public works scheme is higher, whereas in Sellye the number is almost identical with the county seat, although in line with national guidelines, the figures are on the decline everywhere (by 36.5% in two years).

The significance of the public works scheme, as the supported form of employment is demonstrated by the fact that of the 17,764 reported job offers in Baranya 86.8% were linked to a subsidy and 69.5% of these were related to the public works scheme. On the national level, the ratio of subsidised job offers is 70.5%. In Baranya the two extremes are represented by Bóly and Sellye: in the prospering and well managed town of Bóly the proportion of jobs without subsidy is 46.1%, while the number in Sellye, which has become economically peripheral the figure is 0,1%. In Pécs a mere ¼ of job offers did not apply for government subsidy. [35]

In summary it can be stated that the economic and labour market situation in Baranya County is extremely complex: behind the figures we must see that in the large wave of factory closures following 1990, the income generating ability of the region declined and the Elcoteq plant, which manufactured telecommunications devices temporarily in Pécs and recruited workers from the entire county, was only able to relieve unemployment for a short period. The situation worsened after the plant was closed at the beginning of the 2000s, and only escalated with the 2008-2009 crisis. In the meantime, the stream of funds flowing into the county seat were aimed at reviving cultural life, however, the development of revenue generating sectors fell behind, therefore, the Pécs international airport and the Baranya County portions of the M6/M60 motorway are among the most underutilised transport infrastructure in the country. Three types of reactions are possible to the lack of workplaces and low income:

- there is a trend for the decrease of active aged population as a result of migration away from the region;

- the number of persons employed in the state and local government sector has increased without substantive added value;
- the public works scheme was introduced.

In terms of waste management related job creation we must therefore consider that ¾ of jobseekers do not have high school degrees and about half of them only completed elementary school. Unfortunately, this predestines the need for labour-intensive jobs with low added value. This situation can substantially change only if

- group layoffs are performed in the state and local government sector in order to increase efficiency, or
- income levels (including purchasing power) are significantly improved in our region, as a result of which the active age population who have left, return.

Currently either of these is unlikely to occur.

4.2. Labour market situation in Osijek-Baranja

The main indicators of the Osijek-Baranja Prefect:
Area: 4,155 km^2 (7.3% of the country's territory - ranked 4th)
Population: 287,124 (based on 01.01.2017 data, 6.9% of the country's population, ranked 5th)
Administration: 7 towns, 35 local governments and 264 municipalities
Cultivation areas:

- 58% agricultural land
- 20% forest

Compared with 01.01.2014 status the population decreased by 4.2%, i.e. 12,591 persons (the highest decrease was in Slavonia and Baranja, whereas the national average is 2.2%).
In July 2018 there were 86,940 employed and 17,431 unemployed registered persons, therefore, the average unemployment rate was 16.7%, which shows a 2.7 percentage point decline compared with the data for one year earlier, i.e. July 2017. The number of unemployed women is much higher than men: 20.7% against 12.9%. [36]

Several similarities exist between Baranya County and the North Baranja Prefect in terms of the labour market situation:

- **significant agricultural cultivation and food production;**
- **per capita income is below national average;**
- **major national economy-level production investments bypass the region;**

- **the active population is on the decline due to emigration;**
- **as a result the number of job seekers is declining and the population is aging;**
- **the training portfolio and knowledge base of the local university would be capable of serving a much stronger industry and due to the absence of industry, domestic students choose universities in other cities;**
- **the qualifications required in job offers frequently differ from the education of job seekers.**

4.3. Opportunities for Job Creation

In view of the above-listed characteristics of the two counties, if we wish to achieve substantial improvement, the role of the waste management sector in the labour market needs to change within the coming decade. To date this segment was covered by medium to large companies carrying out municipal solid waste collection, landfilling and within the last two decades, preparation of industrial secondary raw materials and only a very small number of small enterprises were present on the market, which performed mostly dirt and debris removal in containers. In the interest of sustainability and setting up of a circular economy, however, a substantial number of processing and recycling plants with large capacity must be established that allow not only capital intensive large companies but also small enterprises and startups to enter the market.

Below are shown the job creation opportunities that can be linked to waste management grouped by value chain (but not shown in order for logistics purposes) which should be considered in Baranya County and bearing in mind the features of the Osijek-Baranja Prefect.

4.3.1. Processing industry

In 2018 a fundamental change took place in the world market of secondary raw materials after China announced that it no longer wishes to be the waste landfill of the developed world, therefore it will cease to import waste. This had a shocking effect on Europe as transport to China made the establishment of processing capabilities within the Continent redundant, therefore this situation is currently causing a shortage of capacities in Europe. In the absence of processing plants the sorting plants are unable to market the secondary raw material produced labour-intensively with selectively collected waste and in the absence of income, the financing of the entire selective waste collection system is called into question.

At the same time, this situation could be beneficial for the purposes of job creation, as the establishment of secondary raw material processing plants will not only be required in Hungary and Croatia, but throughout Europe.
Naturally, the system will only be viable if each element of the entire value chain exists, works and the funds are available for its costs, whether in the form of product sales or a subsidy from the government. The packaging material producers and those consumers who are willing to use products made from secondary raw materials are also included in the value chain. An example for this is Northern Italy, where there is a large number of enterprises involved in waste recovery, which purchase the secondary raw materials produced, thereby providing funds for the extremely costly, but high level selective waste collection and preparatory operations.

4.3.2. Collection

If the processing industry is the omega of the circular economy, then collection is its alpha: the industry requires large quantities of pure-bred, contaminant-free raw materials, which can only be guaranteed by separation that takes place where the waste is generated, i.e. at the source, followed by collection that avoids contamination. In order to achieve a selectivity rate of up to 80%, the logistics (and incidentally also the fees) of both mixed and selective waste collection have to be set up so as to encourage selective collection.
Such incentives can be:

- increase of frequency of selective collection which is supplemented by an accurate and clear annual collection schedule, mobile applications and web2 communication;
- alternative logistics solutions in selective collection;
- apportioning of the fee payable for waste collection and treatment with the amount of waste not collected selectively.

4.3.2.1. Collection frequency

The most beneficial effect of the increased frequency of separate collection on households is that the volume of waste stored in living spaces or other areas of the property (e.g. the garden or the sidewalk) can be decreased. It is not difficult to see that separately collected waste takes up much less space if the container can be emptied every 3-4 days rather than every 14 days. For example, in the densely populated areas of the city of Treviso in Northern Italy, separately collected organic waste, as well as glass, plastic and metal packaging material is removed three times weekly; paper is emptied twice weekly and garden green waste once a week. To achieve this, a logistics method completely different from the one applied today

must be employed: instead of a few large (16-21 m^3) collection vehicles and medium and large, solid walled containers (240-1100 litres), small vehicles (4-7 m^3) and transparent bags and/or small containers (30-120 litres) should be employed. The size of the vehicles should be decreased because if collection frequency is increased, then the quantity collected from 1 household on 1 occasion decreases, therefore only a fraction of the capacity of large vehicles would be used. The reason for this is that the number of properties/households that can be served within an 8 hour shift can only be changed inflexibly depending on the quantity collected from 1 household on 1 occasion, as the time required for completing the route and for emptying the containers is not affected by how full they are. In the case of collection in bags, however, the emptying time decreases as the loading mechanism of the vehicle need not be used, thereby saving about 10 seconds per stop and about 30-35 minutes per shift. Another advantage of small vehicles is that they can enter narrow city streets and ornamental pavements. If the service provider chooses this method, then **it needs to employ large numbers of employees who are able to perform driver and loading work**, as in the case of such vehicles both functions are performed by one and the same person.



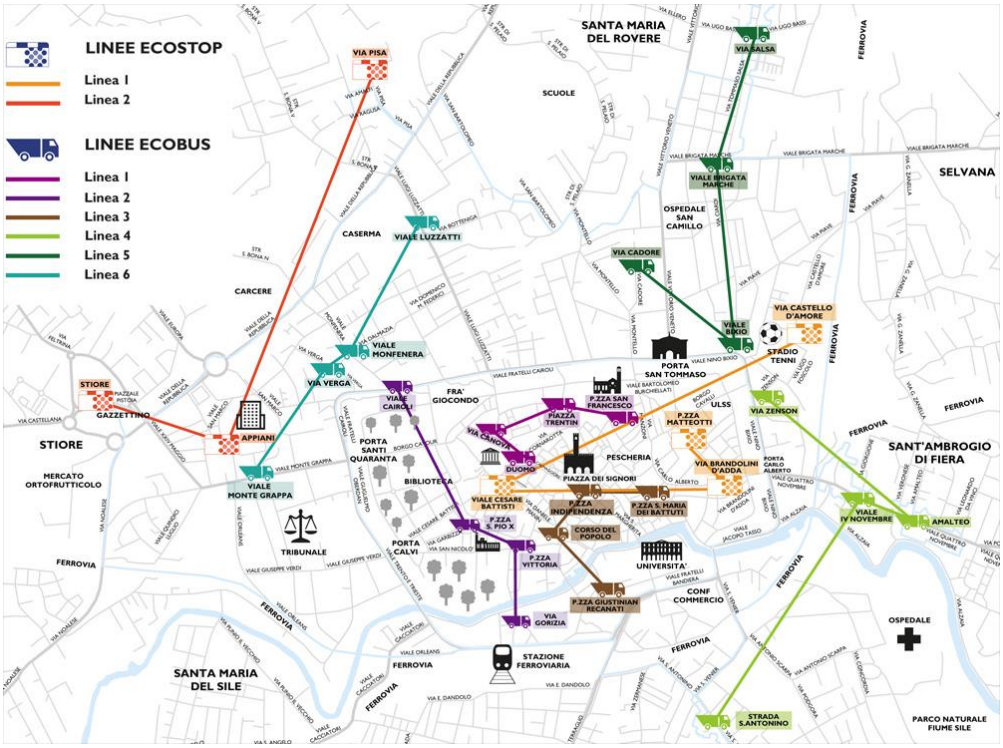
Image: bagged separate collection with small vehicle

4.3.2.2. Alternative logistics solutions

As anyone can be prevented for some reason from placing their separately collected waste at the expected time at the appropriate place, the provision of alternative placement opportunities will increase the willingness of the population to collect waste separately, which can be either a mobile or a fixed device.

In Treviso for example they introduced 2 different selective collection route systems in addition to door-to-door collection:

- The so-called ECOBUS system contains 6 routes which stay for 30 minutes at 4-4 different stops following predetermined routes, allowing the population to place 2 different types of waste in the vehicle (e.g. organic waste and glass+plastic on Mondays, mixed waste and paper on Tuesdays, etc.). The vehicle travels in the evenings on Mondays, Tuesdays, Thursdays and Fridays and on Saturday mornings.
- There are two routes in the ECOSTOP system, one on Monday and Thursday evenings, the other on Tuesday evenings and Saturday mornings. These two routes are able to receive and separately store all four types of waste.



Map: ECOSTOP and ECOBUS routes in Treviso

In Parma, Ecostation containers were installed in 8 locations in the city where people can deposit residual waste and separately collected plastic, metal tins and multilayer drink packaging material, at any time on any day of the week in bags of up to maximum 40 litres. In order to use the Ecostation people must either swipe their city health card or a special eco-card purchased specifically for this purpose. The containers are only emptied when they are full and the containers are observed by camera to determine their saturation.



Image: Ecostation in Parma (own photo)

An additional interesting example is Cigno Verde (Green Swan) Social Association, also in Parma, which performs the separate collection of paper, glass, electronic waste, toner cartridges based on an agreement with the local government. In addition to separate collection they operate a bicycle repair station and participate in caring for public parks in the city. Cigno Verde also employs convicts and performs practical training activities.

Both the Treviso and the Parma **collection solutions require the employment of a large number of drivers of small vehicles.** In Parma, with a population of about 200 thousand, 250 vehicles participate in collection. The Treviso company, which services 554 thousand people employs 701 employees (together with the largely automated waste treatment facilities).
Az olasz példákazt mutatják, hogy jól szervezett és megfelelően finanszírozott rendszerben minden 800 lakosra juthat 1 munkahely a hulladékgyűjtési ágazatban.

4.3.2.3. Modification of tariff system

The issue of the fee payable for waste collection and treatment is only apparently linked to job creation, however, it is an essential element of the system and a flawed system of fees could lead to job losses.
It is a basic tenet that the organisation performing the collection and pre-processing of waste needs to access the funds required for the operation and development of the system from some source. Without this, the organisation uses its reserves, becomes indebted and its operation disintegrates which, in addition to job losses, could cause public health issues in the municipalities affected.

This basic tenet leads to the conclusion that we must act extremely prudently when we wish to apportion the fee payable for waste collection and treatment with the quantity of waste not separately collected, i.e. mixed or residual waste. On the one hand, a certain proportion of the population does not think and behave environmentally consciously, at the same time, their willingness to take responsibility is low which may lead to the minimisation/avoidance of payment and the deterioration of environmental conditions, e.g. the creation of illegal landfills. On the other hand, the collection solutions described in the above two sections are much costlier than classical mixed collection, therefore, while we expect a continuously improved level of service due to environmental factors, due to a decrease in residual waste quantities, revenues may lag behind the costs. A way out of this trap is a functioning, market-based secondary raw material processing industry which is willing to pay for raw materials that can be used for its production.

The case of Treviso, which has been cited many times in this study is instructive from this perspective as well: the waste transport cost payable by the population is the lowest in the country (about €190/household/year) even though they operate an extremely high level and extremely costly separate collection and preparation system. This can be achieved by operating an 85% separate collection rate (out of 386 kg/person/year waste produced only 58 kg/person/year is residual waste), against the Italian average of 47.5% (all data are for 2016). The separate collection rate objective for 2022 is 96.7%, with the residual waste quantity being 10 kg/person/year. In Treviso, the fee has a permanent part, which depends on the number of persons living in the household and a variable part, which depends on the number of emptying. Each plastic container is supplied with a radio frequency identifier (RFID) and the staff performing the emptying record the fact of emptying with a manual reader.

The interesting part of the Parma system is that they use plastic bags with RFID for residual waste collection and the reader is in the back part of the open container of the vehicle. When the bag is loaded on the vehicle, the reader identifies the bag and gives a sound of successful reading. The purchase price of such a bag with RFID is 10 cents. The fee payable by households consists of two parts here as well: the fee has a permanent part, which depends on the size of the property and a variable part, which depends on the number of emptying. E.g. an average 3 member family can expect to pay a €140 permanent fee which includes the emptying of 21 pieces of 50 litre bags. An additional fee must be paid if they have over 21 bags/year. The CONAI (Consorzio Nazionale Imballaggi = National Packaging Material Consortium) pays about €920,000 for valuable secondary raw materials from separate collection, which is not a negligible amount for the purposes of operating the collection and pre-processing system.

The tariff system detailed above has the following job creation potential:

- data processing and evaluation in the collection organisation;
- field inspection;
- production of RFID stickers;
- Production of plastic bags with RFID;
- Production of biodegradable bags according to EN 13432 standard;
- Production, development of RFID readers (proximity readers)

In the previous three sections we only dealt with wast originating from households, however, separate collection of restaurant/large kitchen food waste has further job creation potential which will later be treated in biogas and/or composting plants. In Hungary there is free competition in this segment, but coverage is not complete. Naturally, collection requires drivers in this case as well (biogas and composting plants are not labour-intensive at all, therefore they are negligible for the purposes of job creation).

4.3.3. Reuse

In the interest of the implementation of the circular economy, reuse centres that include renovation workshops must be established, e.g. for furniture, residential accessories, appliances, IT equipment. It would be beneficial to operate this in the form of a non-profit enterprise or social association, employing disadvantaged employees. These types of spectacular plants would also be well suited for raising popular awareness of environmental issues. Currently, the only attractive facilities are manual sorting plants related to the middle level of the waste management hierarchy, i.e. recycling, through plant visits organised for kindergarten and school aged children. Reuse centres target higher levels of the hierarchy which are both socially and environmentally more preferable and are also suitable for strengthening solidarity among city-dwellers.

Three types of reuse centre worthy of consideration are:

- Simple depots are the least labour intensive where redundant equipment need only be stored and can be used without change / intervention.
- Plants where incoming objects need to be repaired or renewed before becoming suitable for reuse, require the involvement of large numbers of employees.
- Plants where furniture and other furnishings are dismantled to pieces and then reconstituted and remodeled into new objects with different functions require the largest number of resources. This not only demands manual skills but also design abilities so the engagement of industrial designers is also a possibility.

4.3.4. Waste treatment facilities

In the Osijek region on the short and mid term several kinds of technological developments are possible which go hand in hand with the creation of new jobs.

On the short term a mobile shredder can be installed in the existing waste landfill, which will enable the reduction of the volume of deposited materials and render the compression of waste more efficient. This investment could create a job for one or two machine operators.

On the medium term, a new regional centre will be established in the town of Orlovnjak-Antunovac, with installation expected for 2022. The centre is currently in the planning phase, but based on the national plans it is sure to include a manual sorting plant, a composting plant and a waste landfill. The operation of such a site requires about 30 employees, including the scale operators, the manual sorting staff, machine operators, drivers within the site, the management and administrative staff and the guards.

4.3.5. Training, Raising Awareness, Incubation

4.3.5.1. Training

Practical training programmes should be launched to address a wide spectrum of the population, the aim of which is to minimise waste quantities, while the subject would be the repair of personal effects, naturally also including accident and contact safety measures. The above-mentioned reuse centres could be suitable venues for holding the practical parts of the training programmes.

Considering that communal waste and construction and demolition waste are represented in equal proportions among the waste generated, the training of construction entrepreneurs and their employees is advisable with regard to the separate collection and treatment of recoverable secondary raw materials generated during construction and demolition processes. What we experience in practice is that inert and communal waste is mixed during construction and renovation works, which makes subsequent recovery more difficult and also leads to excess costs, as the gate fee payable for mixed waste is higher than that of inert waste.

4.3.5.2. Raising awareness

Successful examples all show that the focus should be on individual responsibility in order to transform decade-long mindsets and for attitudes toward waste to change dramatically. To this end, informative campaigns and programmes need to be realised that promote prevention, reuse and recovery, among others by presenting responsible consumer behaviour and providing other lifestyle advice.

Local governments and in particular mayors play a crucial role in raising awareness, as s/he is the person who sets an example for citizens both in terms of mindset and behaviour. The local government (and government) sector is able to set an example through green public procurement, thereby also assisting the "green" industries as the secondary raw material processing industry is viable if there is a market for purchasing recycled products. Green public procurement systems can include factors such as environmental burdens on product life-cycle, lifespan, repairability, opportunities for reuse, proportion of secondary raw material used which all point in the direction of the circular economy.
In the interest of avoiding that personal effects should become waste prematurely, in the public and private sectors, rather than buying new products, new commercial concepts should be introduced to promote services, rental or sharing. In these cases the service provider / owner is interested in choosing the most durable possible product which will produce an income for their enterprise for a long period. Some photocopying companies operate this way, but Rolls-Royce has also earned its sales revenues for decades based on the amount of energy produced by its industrial equipment and not via product sales.

4.3.5.3. Incubation

Incubation is necessary in the case of young/startup entrepreneurs who are interested in the processing or reuse industry: services can include not just providing a site, but also company management training, financial advice, attraction of investors (including jointly with the professionals of the university and the industry chamber). For boosting the sector it would be worthwhile to establish and operate a so-called living lab, the members of which can together work out and evaluate new product and service ideas and can generate cooperation in innovation. If the sector is fortified, the players can form clusters, which, in optimal cases, does not only mean sharing of information, but also development, design and marketing costs. Naturally, both the living lab and the cluster require company managers who are committed to cooperation and are willing to regularly commit time, as experience shows that without the above, these kinds of initiatives wither away on the long run.

The activities described in this chapter require the involvement of a knowledge base: media experts, educators, financial and special entrepreneurial experts, project managers, lawyers. The competent employees of the industrial chambers and universities should be involved in both planning and implementation.

5. References

[1] Landfill mining toolkit - Municipal waste (http://smart-ground.eu)

[2] National Waste Management Plan 2014-2020

[3] Hilda Farkas PhD. Experiences of closing down waste landfills

[4] www.dontwasteit.hu/2016/03/06 /ujrahasznositasban-nemetorszag-az-elen/

[5] Zsolt András Hajnal: New factors in technical and professional expectations (Lecture, Siófok 23 Nov 2016)

[6] Tibor Kiss: Efficiency and systems approach in municipal solid waste management Thesis

[7] Ilona Pálné Kovács, István Finta: Legal regulation and professional policy environment of local government public services, 2013.

[8] Act CLXXXV of 2012, Section 32/A (1)

[9] National Waste Management Public Service Plan 2017

[10] NFM Decree 13/2016 (V.24)

[11] Controlling database of BIOKOM Nonprofit Kft and Dél-Kom Nonprofit Kft.

[12] Dr. László Alexa; Tibor Kiss; Dénes Olessák: Waste Management Manual II 2005

[13] D1.1 General Assessment of SRM in Europe and Selection of Target Pilot Landfills (http://smart-ground.eu)

[14] Az Európai Parlament és a Tanács (EU) 2018/851 irányelve (2018. május 30.) a

[15] http://ec.europa.eu/environment/waste/framework/end_of_waste.htm, las on 30/07/2018.

[16] www.szelektivinfo.hu, last veiwed: on 30/07/2018.

[17] https://ec.europa.eu/growth/tools-databases/eip-raw-materials/en/content/european-innovation-partnership-eip-raw-materials, last viewed: on 30/07/2018.

[18] D2.3. Material Flow Maps (http://smart-ground.eu)

[19] http://ec.europa.eu/growth/sectors/raw-materials/specific-interest/critical/index_en.htm), last viewed: on 30/07/2018.

[20] National Collection and Recovery Plan 2018

[21] Zoltán Pápai: Proposed changes to the National Waste Management Public Service Plan, Balatonalmádi, 19 October 2017

[22] National Waste Management Public Service Plan 2017

[23] hirek.logportal.hu, last viewed: on 30/07/2018.

[24] www.kormany.hu, last viewed: on 30/07/2018.

[25] temékdíjinfo.hu, last viewed: on 30/07/2018.

[26] bovaconsulting.hu, last viewed: on 30/07/2018.

[27] Waste Management; Kaszáné Dr. Magdolna Kiss; 2013 Debrecen University

[28] Waste Management Strategy of the Republic of Croatia, OG No. 130/05

[29] SEVENTH NATIONAL COMMUNICATION AND THIRD BIENNIAL REPORT OF THE REPUBLIC OF CROATIA UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE, (UNFCCC), April 2018
[30] Decision on the adoption of the Waste management plan of the Republic of Croatia for the period 2017-2022, OG No. 3/17
[31] Act on Sustainable Waste Management (OG 94/2013).
[32] http://envi-portal.azo.hr, last viewed: on 30/07/2018.
[33] maps.google.com.
(34) Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste
[35] Dr. Éva Tigelmann: Labour market situation in – Baranya County 2018 (presentation, 06.09.2018 Osijek)
[36] Beba Madunovic: Trziste rada Osjecko-baranjska zupanija (presentation, 06.09.2018 Osijek)