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NEW TRENDS IN COMMUNAL WASTE MANAGEMENT AT THE REGIONAL LEVEL: WASTE TREATMENT PLANTS IN HUNGARY AND PRACTICAL APPLICATIONS

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Abstract

The waste management is increasingly important from the point of view of our future and to keep our environment safe for the future generations to come. The European Union sets up strategic objectives and goals on priorities and actions in the field of waste management. The Waste Framework Directive 2008/98/EC stipulates and sets forth the goals and actions for the next decades. The paper deals with the European strategy and the Hungarian practices with special focus on the North-Balaton communal waste disposal facility.

Key words: recycling, RDF technologies, regional waste management, waste-management

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1. Introduction

With modern economy, waste as a by-product has been produced in vast amounts. The constantly increasing amount of waste has generated local, regional and global environmental impacts as well. After the recognition of the negative impacts of the communal waste disposal practices, local acts were fostered by the communities at national and international levels.

To accomplish the common objectives strategies and action plans had to be developed by nations due to the border crossing impacts of the environmental pollutions and the need of customized management of the similar problems. Moreover in the EU common regulations are required to support the international commerce of recycled and recyclable materials.

To accomplish the above mentioned objectives waste management regulations and systems need to be harmonized in the EU and parallel with these goals new trends are shaping up regarding the waste management systems and facilities.

Though the level of the technology and the cost of waste management and handling are reflecting the economic strength of the different countries, similar trends can be observed among the member states of the European Union.

At national and regional level waste management systems with new technologies have been implemented in Hungary with the support of EU funds. In the North-Balaton Region a unique waste management system has been planned and it is under realization to reach the ambitious goals of reducing the amount of wastes for final disposal at landfill sites, and to increase the recycling rates and activities and to produce energy and secondary raw materials from the waste (Refuse Derived Fuel/Solid Recovered Fuel) for the industrial utilization.

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2. Review on the EU strategy - waste management

To set up regulations and strategic goals at different levels, priorities had to be specified at European Level. As a result of this effort, waste management priority pyramid (Fig.1.) had been established as the hierarchy of the favoured actions. Waste management regulations of the Member States should follow the priority depicted in Fig. 1 in order to support the decision making for the establishment of appropriate waste management systems at local level.

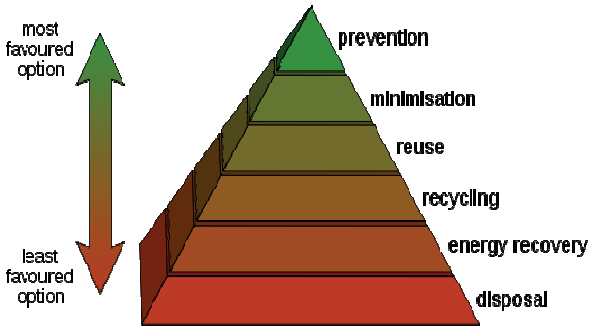

Fig. 1. Waste management hierarchy

2.1. European Union requirements for waste management

The Waste Framework Directive, namely the Directive 2008/98/ EC (Waste Framework Directive) stipulates and summarizes the effort of the European Union and nations to set up the goals for the upcoming decades (EC Directive, 2008).

The Directive outlines the basic concepts and definitions of waste management (waste recycling, recovery, reuse), and provides definition regarding the potential secondary raw materials. According to the Directive the member states should elaborate their waste prevention program by December 12, 2013 to specify the goals and target figures regarding the recycling and reuse. The most important goals are as follows: selective collection for metals, plastics and paper by 2015, minimum rate is 50%; preparation for recycling of these fractions by 2020; minimum 70% recycling rate for masonry or rubble waste by 2020. The Directive also sets the goal for the selective collection and handling of the bio-waste, encourages the use of products originating from the waste management systems by treatment and preparation. It emphasises the need of the distinctive handling of the hazardous waste (prohibition on mixing different hazardous wastes), the separate collection of waste oils (with are constantly increasing in quantity), supporting the recycling and regeneration. The Directive enforces the extended producer's responsibility (EPR) at member state level and focuses on the principles of self-sufficiency and proximity. The document outlines the minimum criteria of such types of activities that require registration, and help in setting up the end-of-waste criteria (EC Directive, 2008; Hoornweg and Bhada-Tata, 2012).

2.2. European waste managment implementation and strategy

In the member states different main streams had been elaborated regarding the waste collection systems and treatment/processing technologies used or to be used. Following the EU's hierarchy from waste prevention to waste disposal, the first issue to be addressed is the determination of the wastes actually generated. These figures vary country by country, and it can be concluded that the countries with higher GDP tend to produce more waste per person. In 2012 municipal waste generated per person varied from 294 kg in the Czech Republic to 801 kg in Denmark (Table 1). Low level waste amounts were reported for Romania, Latvia, Poland and Slovakia. Hungary has exhibited a figure of 456 kg per capita in year of 2012.

Out of all the municipal waste generated in the EU, 53% is taken to landfilled, 14% is recovered and 15% is taken for incineration. Countries with lower GDP still have been using mostly the landfill technique, while countries with higher GDP have been focusing on incineration.

The highest amounts of wastes taken for landfill can be observed in Bulgaria, Romania, Lithuania, Malta and Poland (90% or more). On the other hand Germany, Belgium, the Netherlands and Austria recycle or compost significant part of the wastes (59% or more); while Denmark, Luxembourg, and Sweden incinerate the wastes in the highest proportion (47% or more). In Hungary waste taken for landfill is 90%, for incineration 6%, recycling 3% and for composting 1% (Maurer, 2009; EEA, 2007; Euractiv, 2009). Under the green arrow in Fig. 2 the layers represent the most preferred cases and the layers under the red arrow represent the least favoured situation (the landfill deposition is absolutely not preferred).

The Hungarian regional projects (NDA, 2013) follow the Austrian and German practices and the projects are planned with mechanical and biological treatment facilities as well. Other countries – such as Switzerland and Baltic countries – focus their efforts on the incineration and in some cases the zero deposition to landfills is achieved.

In order to accomplish these important objectives and to implement these expensive investments, the EU provided significant (up to 90%) financial support from their funds – ISPA (Instrument for Structural Policies for Pre-Accession) and Cohesion Funds to Hungary (NDA, 2013). These new waste management systems allow increasing the amount of the handled waste from 250,000 T/yr to 1,900,000 T/yr (Bagi, 2007) in a short period of time (app. in 10 years). On the other hand the EU obliges the member states to reduce the amounts of municipal solid waste taken to landfill by 65% by 2016 as compared to 1995 levels.

3. Hungarian practices

3.1. Mechanical biological treatment (MBT) plants – new directions for the Hungarian waste management

In the 90's revisions were carried out for the operating landfills in order to set up the criteria for the future operation. 2,667 landfill sites had been investigated and only 77 sites were qualified and permitted to continue the operation (Fig. 3).

The closure and recultivation of the old facilities with the construction of new regional facilities within ISPA and Cohesion Fund projects were successful in the Hungarian waste management in spite of the negative impacts excised on the waste fee (Bagi, 2007).

Even some decades earlier the Hungarian waste management practices were based only on dumping the waste at different places, e.g. at abandoned mines.

Table 1. The municipal solid waste generated and handled in the EU27 (Hoornweg and Bhada-Tata, 2012)

Country	*Municipal waste generated kg per person*	*Dumps %*	*Landfills %*	*Compost %*	*Recycled %*	*Waste to Energy %*	*Other %*	*Data*
Austria	**597**	0	6.75	44.72	26.54	21.10	0.90	2012
Belgium	**492**	0	11.57	22.77	31.10	34.32	0.00	2012
Bulgaria	**468**	0	82.90	0.00	0.00	0.00	17.10	2012
Cyprus	**754**	0	87.20	0.00	0.00	0.00	12.80	2012
Czech Republic	**294**	0	79.78	3.24	1.27	13.97	1.74	2012
Denmark	**801**	0	5.09	15.28	25.57	54.04	0.03	2012
Estonia	**536**	0	64.00	2.00	34.00	0.00	0.00	2007
Finland	**507**	0	53.00	10.00	26.00	12.00	0.00	2007
France	**541**	0	34.00	14.00	16.00	36.00	0.00	2007
Germany	**564**	0	1.00	18.00	46.00	35.00	0.00	2007
Greece	**448**	0	92.00	0.00	8.00	0.00	0.00	2012
Hungary	**456**	0	90.00	1.00	3.00	6.00	0.00	2012
Ireland	**786**	0	66.00	0.00	34.00	0.00	0.00	2012
Italy	**550**	0	54.00	33.00	0.00	12.00	0.00	2012
Latvia	**377**	60	40.00	0.00	0.00	0.00	0.00	2012
Lithuania	**400**	0	44.00	0.00	4.00	2.00	50.00	2012
Luxembourg	**694**	0	19.00	19.00	23.00	39.00	0.00	2012
Malta	**652**	0	88.00	0.00	0.00	0.00	13.00	2012
Netherlands	**630**	0	2.00	23.00	25.00	32.00	17.00	2012
Poland	**322**	0	92.00	3.00	4.00	0.00	0.00	2012
Portugal	**472**	0	64.00	6.00	9.00	21.00	0.00	2012
Romania	**379**	0	75.00	0.00	0.00	0.00	25.00	2012
Slovak Republic	**309**	0	78.00	1.00	1.00	12.00	7.00	2012
Slovenia	**441**	0	86.00	0.00	0.00	0.00	14.00	2012
Spain	**588**	0	52.00	33.00	9.00	7.00	0.00	2012
Sweden	**518**	0	5.00	10.00	34.00	50.00	1.00	2012
United Kingdom	**572**	0	64.00	9.00	17.00	8.00	1.00	2012
EU 27	**524**	**2.22**	**53.20**	**9.93**	**13.98**	**14.65**	**5.95**	

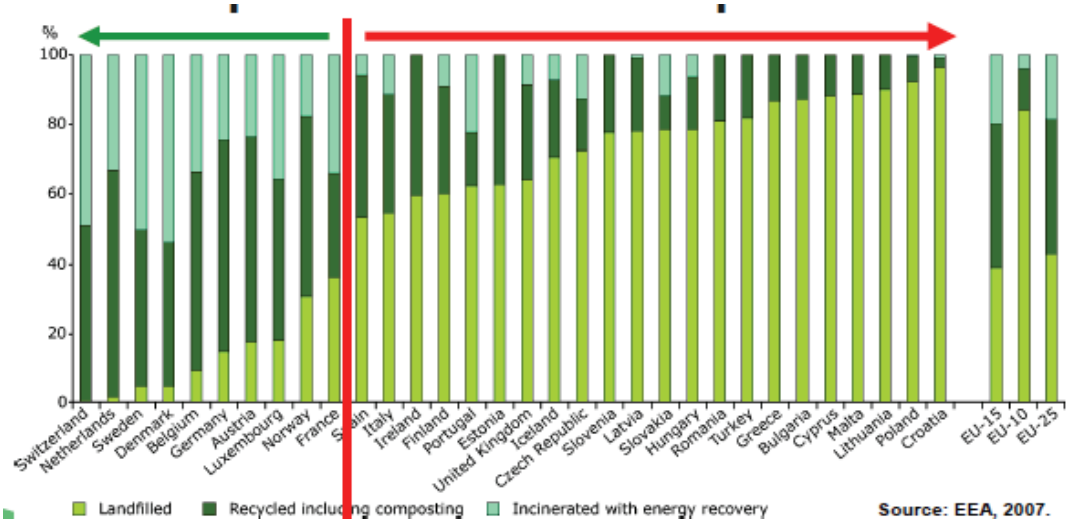

Fig. 2. Different MSW management practices in the EU 27 (EEA, 2007; Maurer, 2009)

In better cases these pits were located on geological insulated areas. This resulted in many contaminated sites with high soil, underground, air and water pollutions. According to the Landfill Directive 1999/31/EC the non-complying landfills had to be closed down within eight years after the introduction of the Directive.

To reach the minimum level regarding the protection of the environment the Pre-Accession Funds had been made available for Hungary even before joining the EU. The use of the EU funds gave possibilities in the late 90's to start to outline the Hungarian strategies of National Waste Management Plan which were transformed into strategic action plans and provided a framework to build up the system of the Hungarian subsidies. The Hungarian Act CLXXXV of year 2012 on Waste Management translates the strategy into practical applications (Act, 2012). Acts, regulations, and standards have been stipulated for all types of industrial activities in order to implement systems which meet the criteria of "Best Available Techniques" (BAT) and "Best Available Techniques Not Entailing Excessive Costs" (BATNEEC) (EC Directive, 1984; EC Directive, 1996).

3.2. The new waste management technology for the North-Balaton Region

One of the most visited areas in Hungary is located around the largest Central-European lake, called Lake Balaton. This area is not only famous for its tourism and beautiful nature but also became a national park in 1997. It was a priority to focus on the wastes management in order to contribute to the safe environment in this region and to upgrade the environmental quality. The project area covers 158 municipalities with five centres (Pápa, Ajka, Tapolca, Veszprém and Balatonfüred) (Fig. 4). The mechanical and biological treatment plant with the regional landfill is situated in Királyszentistván, built on an abandoned industrial site.

For this reason two-step municipal solid waste (MSW) collection system is used to transfer the waste to the Királyszentistván disposal centre. For the selectively collected waste new facilities were established at all five centres. According to data obtained from the local servicing companies the following MSW quantities had been calculated (Table 2). This provided the base for the technological planning and process design. Regarding the selectively collected materials the following figures had been calculated and shown in Table 3.

3.3. Complex system and the technology

The complex waste-management system should focus on the different types of MSW, the selective collected waste and also on the recultivation of closed landfills as a key part of the complex task. In the followings these parts of the complex project are addressed and dealt with.

3.3.1. Collection of mixed municipal solid waste

The mixed household waste is collected by special trucks. At a distance of max. 50 km from the mechanical biological treatment facility the trucks transport the waste directly to the plant. The transfer stations are used to optimize the cost by pressing the waste into special container for the efficient transportation. North-Balaton project should comply with the objective set forth to reach that only 30% of the incoming mixed MSW is taken for disposal at the landfill site after removing the recyclable and utilizable fraction for incineration (Refuse Derived Fuel-RDF or Solid Recovered Fuel –SRF). The used methods and equipment can provide the necessary RDF/SRF fraction to the cement industry or power plants. In order to separate the mixed waste into different fractions the following technology has been specially designed according to the demands of communities, technological goals, environmental regulations and project budget.

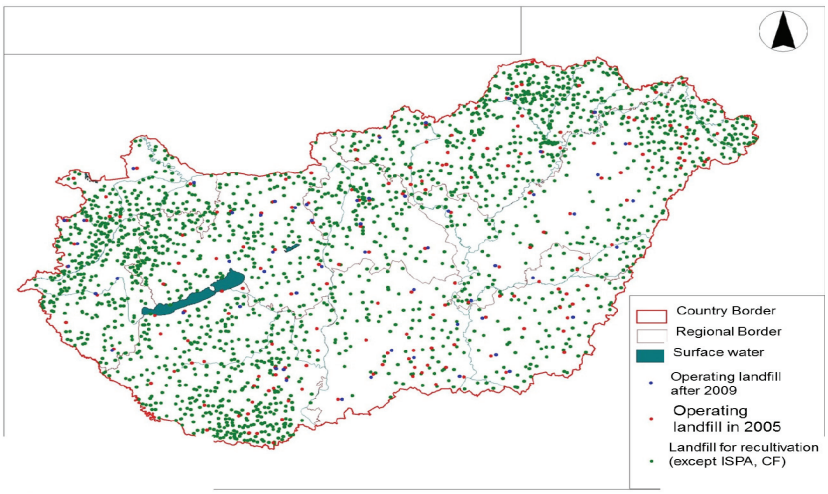

Fig. 3. Landfills in Hungary in 2005 (red spots), in 2009 (blue sports) and landfill for recultivation (green sports)

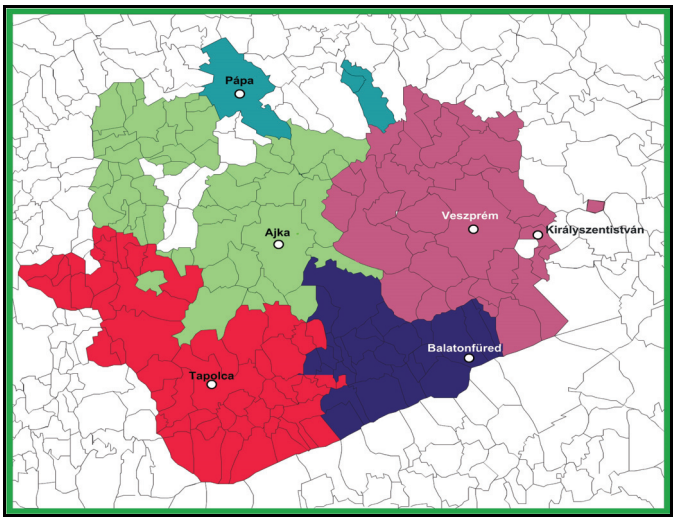

Fig. 4. Project area with MSW technology centres in the North-Balaton Region

Table 2. MSW handled at mechanical biological treatment plant of North-Balaton Region

MSW handland at MSB plant ton/year						
Year	***Ajka***	***Balatonfűred***	***Pápa***	***Tapolca***	***Veszprém***	***Sum***
2013	17293	11156	16603	9785	23349	**78186**
2014	16981	10461	16399	9449	23367	**76657**
2015	16879	9562	16355	9300	23004	**75100**
2016	16774	8641	16310	9149	22633	**73507**
2017	16661	7687	16260	8990	22244	**71842**
2018	16538	6678	16202	8821	21829	**70068**
2019	16676	6667	16343	8884	22011	**70581**
2020	16815	6655	16485	8948	22194	**71097**
2021	16954	6640	16628	9012	22377	**71611**
2022	17095	6626	16772	9076	22561	**72130**
2023	17237	6608	16917	9140	22746	**72648**
2024	17379	6591	17064	9205	22932	**73171**
2025	17523	6572	17211	9270	23119	**73695**
2026	17698	6638	17383	9363	23377	**74459**
2027	17875	6704	17557	9457	23638	**75231**
2028	18054	6771	17733	9551	23901	**76010**
2029	18234	6839	17910	9647	24167	**76797**
2030	18417	6907	18089	9743	24435	**77591**

Table 3. Selective waste managed at regional centres of North-Balaton Region

Selective centres, ton/year				
Year	***Ajka***	***Pápa***	***Tapolca***	***Veszprém***
2013	2287	1744	2046	9115
2014	2796	2131	2500	9569
2015	3096	2360	2768	10595
2016	3401	2592	3041	11638
2017	3715	2832	3322	12713
2018	4041	3081	3614	13831
2019	4109	3133	3675	14064
2020	4178	3185	3736	14300
2021	4249	3239	3799	14542
2022	4320	3293	3863	14786
2023	4393	3349	3928	15035
2024	4467	3405	3994	15287
2025	4542	3462	4061	15543
2026	4587	3497	4102	15699
2027	4633	3532	4143	15856
2028	4679	3567	4184	16014
2029	4726	3603	4226	16174
2030	4773	3639	4268	16336

The requirements of the end-users of RDF/SRF in Hungary also had been taken into consideration in the planning phase. Regarding the technology the key criteria was to devise a flexible technology for all possible emerging requirements set by the cement industry and power plants (Fig. 5). Pyrolysis technologies also are future possibilities that should be borne in mind.

- *pre-shredding:* It prepares the MSW for the mechanical processing by homogenisation of the material in size and material. Also opens up plastic dust bags and homogenize the material in size to app. 300 mm.
- *Ferrous metal separation*: important to protect the technology from damages. It also produces recyclable material (1.5-2%).
- *Screening*: The drum screen separates the pre-shredded waste into two fraction as 85% of biological fraction is in the range of 0-60 mm of the input waste. The waste stream towards the biological stabilisation is about 48-54%.
- *Biological fraction:* During the biological treatment 50% of the input waste weight is removed by bio-degradation processes. With the production of RDF and recycled fractions only 30% of the input waste is planned to be deposited at the landfill site as a bio-stabilized waste.
- *Double air separation*: The fraction above 60mm is passed through of an air separator, where air stream is introduced to the conveyor lane. The materials with the highest density are falling off whilst the lighter ones are taken by the airflow to the next air separation stage. The removed heavy parts (mainly inert parts) amounts to 10-12% of the inlet stream and used for road building.
- *Non-ferrous metal separation*: The lighter fraction is passed through an eddy current separator, where non-ferrous metals are removed by the electro-magnetic technique. The removal rate is about ~1%.
- *Near infrared (NIR) optical separation*: The lighter parts are passed through the NIR separator in order to remove the different plastic components. The most important issue is to remove the halogen containing materials from the waste (mainly PVC) as it is vital to produce high quality RDF/SRF.
- It can also remove the different types of plastics (that can be useful to adjust the heat value or to recycle different materials from the waste stream).
- *Post- shredding:* It is used to reach the required particle size with different screen sizes (50 mm is preferred). The amount of RDF/SRF is estimated to be around 31-39.5%.
- *Landfill:* The landfill site is insulated properly according to the latest standards (GD, 2006).

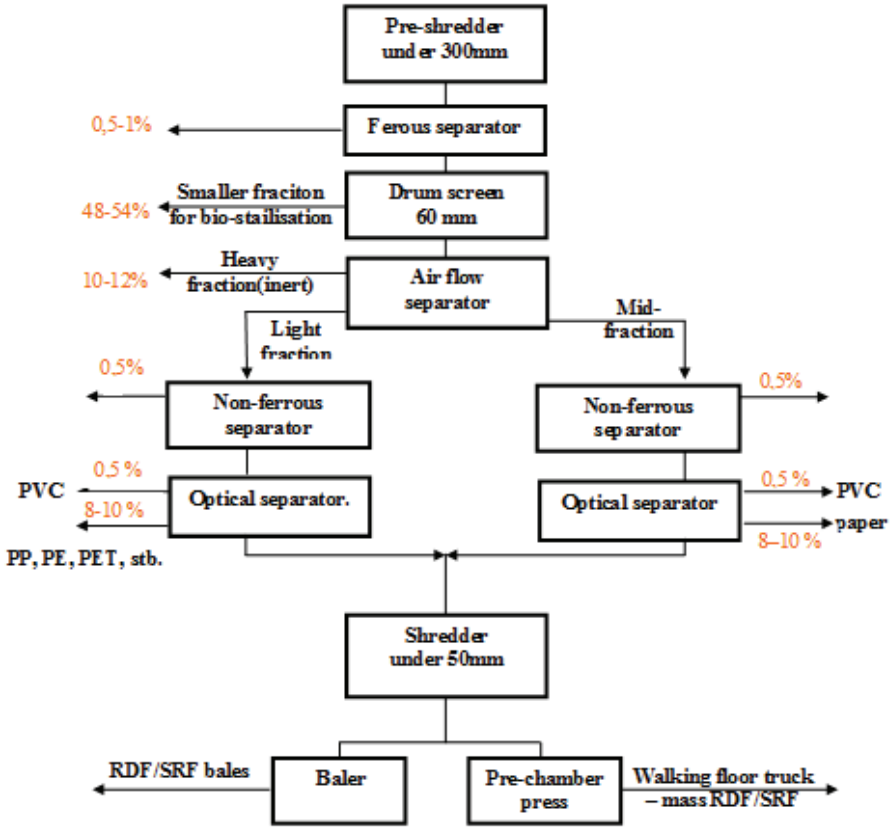

Fig. 5. Technology for North-Balaton Regional waste management system (Recycling, RDF/SRF production, bio stabilisation)

The passive protection (different layers of insulation and protection) with the built-in monitoring system helps to prevent any contamination and provide fast and reliable monitoring on the state of the landfill and the environment. In order to decrease the quantity of the deposited waste and to enforce the use of MBS technologies in some cases limits were defined for the heat value of the deposited waste to be below 6000 MJ/kg (e.g. in Austria). This stipulation can be observed with the appropriate processing technology according to the project (LeBlanc, Matthews, Richard, 2008).

3.3.2. Selectively collected wastes

In addition to the mixed MSW the selectively collected wastes are the most important part of the new waste-management system. In long-term the amount of these wastes should increase continuously.

In this project, plastics, papers, glasses, metals are the most important fractions to be collected separately. The main goal is the recycling of these types of materials. The aim of the bio-waste collection is also to divert the waste from the landfill since strict limitations are in force regarding the biomaterial-content of the treated municipal solid waste (MSW). To reach the above mentioned goals selective collection "islands" had been built in the region and new lines were introduced that only collect the selectively collected wastes directly from households. Bio-plants and composting facilities are also part of the North-Balaton project.

After the collection and transportation four facilities (Ajka, Pápa, Tapolca and Veszprém) are used to manually separate (clean) the fraction for further handling.

To catalyse the recycling rate of utilizable waste fractions special marketing and dissemination programs are initiated and accomplished. It is also important to develop the collection system in order to give easy access for the habitants for the selective collection.

3.3.3. Cultivation, elimination of polluting sources

As the third action of the North-Balaton Regional project it is also a real challenge to close down and recultivate all legal and illegal landfills that had been in use previously. In this region there were about 110 such landfills. Almost 50% of the environmental funds are being used on such activities. These projects also focus on the elimination of all hazardous wastes (relocating, recultivation).

3.4. Products – recycled materials, RDF, compost.

With the realisation of the above described project, outputs should also be in focus. It is very important to introduce these materials into the industrial activities and economy again at regional level.

According to the new waste directive the recycling and reuse have the priority (Act, 2012). For this goal the Hungarian government provides financial support for the collection and use of such types of materials. These materials should not be limited for countries as the global European market is also open for these secondary raw materials and this can speed up the development of the waste industry. Good preparation and strict legislation are required to strengthen the confidence in these secondary raw materials at international level.

Refuse Derived Fuel (RDF) or Solid Recovered Fuel (SRF) are becoming an important energy source. By mechanical treatment the RDF/SRF can be produced in large quantities – 26000 T/yr in the North-Balaton Regional project. This homogenous material consists of particles with size of 50 mm. This material consists of plastics, paper, wood and textile and these fractions can be used in power plants and in the cement industry.

With the separate collection of bio-waste and green waste the composting plants can produce high quality compost which can be put onto the market as product. This can contribute to the sustainable agriculture also. In the North-Balaton Region the above described technology is under construction for the production of SRF material according to the SRF standard (Act, 2012).

4. Conclusions

In the Hungarian waste industry significant changes can be seen within a short period of time. With joining the EU not only the goals and technologies should have had to be harmonized but also the financial support had to be provided. The new technologies and driving forces influenced the legislation and policies. This development has contributed to the increase of the standard for the technologies to be used. The practical realization shows differences among the countries of the EU. In Hungary MBS plants were preferred at national level and become preferred choice for the regional EU funded projects.

For the North-Balaton Region the technology had been designed to comply with the challenging goals and state-of-the-art technologies (such as NIR optical selection). The government puts a high attention onto the recycling and provides benefit for the industry regarding the use of waste as a replacement material (raw material and energy) since the primary raw materials are still in many cases cheaper and exhibit better properties. In addition to the recycling and waste handling the recultivation is also important at regional waste management projects.

In the North-Balaton Region all of these goals have been reached by the support of EU funds. The best practices in regional practical applications should be shared and disseminated at national and

international levels to establish the new trends and tasks for the waste industry.

Acknowledgements
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