Urban waste for biomethane grid injection and transport in urban areas

Project No: IEE/10/251

Waste Management Concept for Valmiera City

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UrbanBiogas website: www.urbanbiogas.eu

Contents

Glossary

waste treatment – the physical, thermal, chemical or biological processes that change the characteristics of the waste, in order to reduce its volume or hazardous nature, accelerate decomposition or facilitate its handling and enhance recovery;

biodegradable waste (bio waste)- waste capable of undergoing aerobic or anaerobic decomposition;

biomethane – methane gas (≥97 %), produced by organic waste decomposing in anaerobic conditions or from specially grown biomass; biomethane may be used as a source of energy for producing heat, electricity or transport fuel;

bioreactor – different technological solutions for anaerobic fermentation facility to provide anaerobic treatment of bio waste by reducing organic matter content and producing biogas as a by-product for further use in generation of energy;

municipal waste — all types of solid *waste* generated by households; trade or service processes or any other waste, which, because of its nature or composition, is similar to the waste from household.

RWMC – Regional Waste Management centre

1. Introduction

The Project UrbanBiogas (Biomethane production from municipal waste for injecting it into the gas grid and use in the city public transport) is supported by the European Commission programme "Intelligent Energy for Europe".

Within the framework of the project a concept has been developed for municipal waste management in Valmiera City. Considering the project setup, the focus is on solutions for bio waste management. Municipal waste management has been analysed in the context of optimal management of bio waste. Biogas utilisation concept will be developed on the basis of the waste management concept permitting Valmiera City to consider and start production of biomethane from organic fraction of the municipal waste and use of the biomethane in the public transport or waste management transport.

2. Municipal waste management

The chapter gives a short description of municipal waste management in Latvia, including the amount of the produced waste and division of waste by sectors. An analysis of Latvia's waste management system is given alongside Latvia's goals regarding biodegradable waste management and normative acts, etc.

2.1 Characteristics of the produced municipal waste

According to Latvia State Waste Management Plan for 2006-2012, territory of Latvia is divided into 11 waste management regions with their own regional sanitary landfill.

Summary of data for unsorted MSW from years 2000 - 2010 shows that the average composition of household solid waste has changed. The part of bio waste is reduced from 49.5% (in 2000) to 38.5 % (in 2010). Significant changes have occurred in the composition of packaging material, as shown below in Figure 1. The percentage of plastic waste has increased from 4.8% to 11.96% but paper and cardboard from 14.5 to18.2%. On the other hand glass packaging has decreased from 13% to10%. There are significant regional variations in waste composition; especially rural regions have smaller proportion of bio-waste in MSW because most of private households practice home composting for kitchen waste.

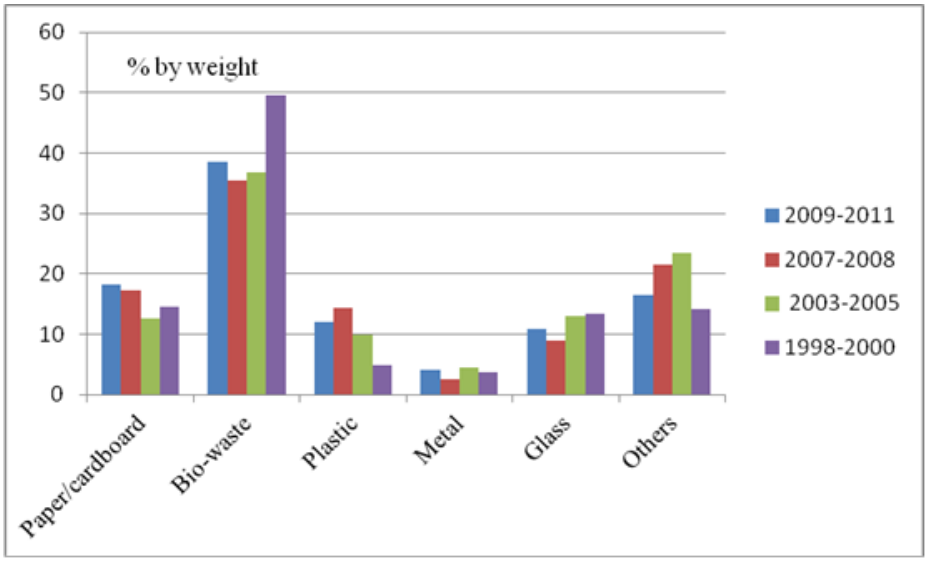

Figure 1. The average composition of solid household waste (years 2000 – 2010)

According to the statistical data, the amount of waste collected in Latvia in 2010 was 1375500 tons. The amount collected in North Vidzeme Region in 2010 was 50978.04 tons constituting less than 4 % [1].

The largest flows of the total waste are:

- municipal waste or any other similar waste from trade and industrial waste;
- enterprise and institutional waste, as well as separately collected waste types – 65.44%;
- construction waste (also road building) and demolition waste – 11.16%;
- non-organic waste from thermical processes – 7,62%;
- waste from waste management companies, waste water treatment plants and water supply companies – 6.99%.

These four waste flows together constitute more than 91% of the total amount, a substantial part of it being municipal and similar waste with the total amount of 900 000 tons.

Comparing the data of the produced and the collected amount of waste in 2010, we can see that the collected waste amount exceeds the amount of the produced waste by almost 550 000 tons: this difference is explained by the fact that the data on the produced waste do not include households and companies which do not provide statistical reports of the produced waste.

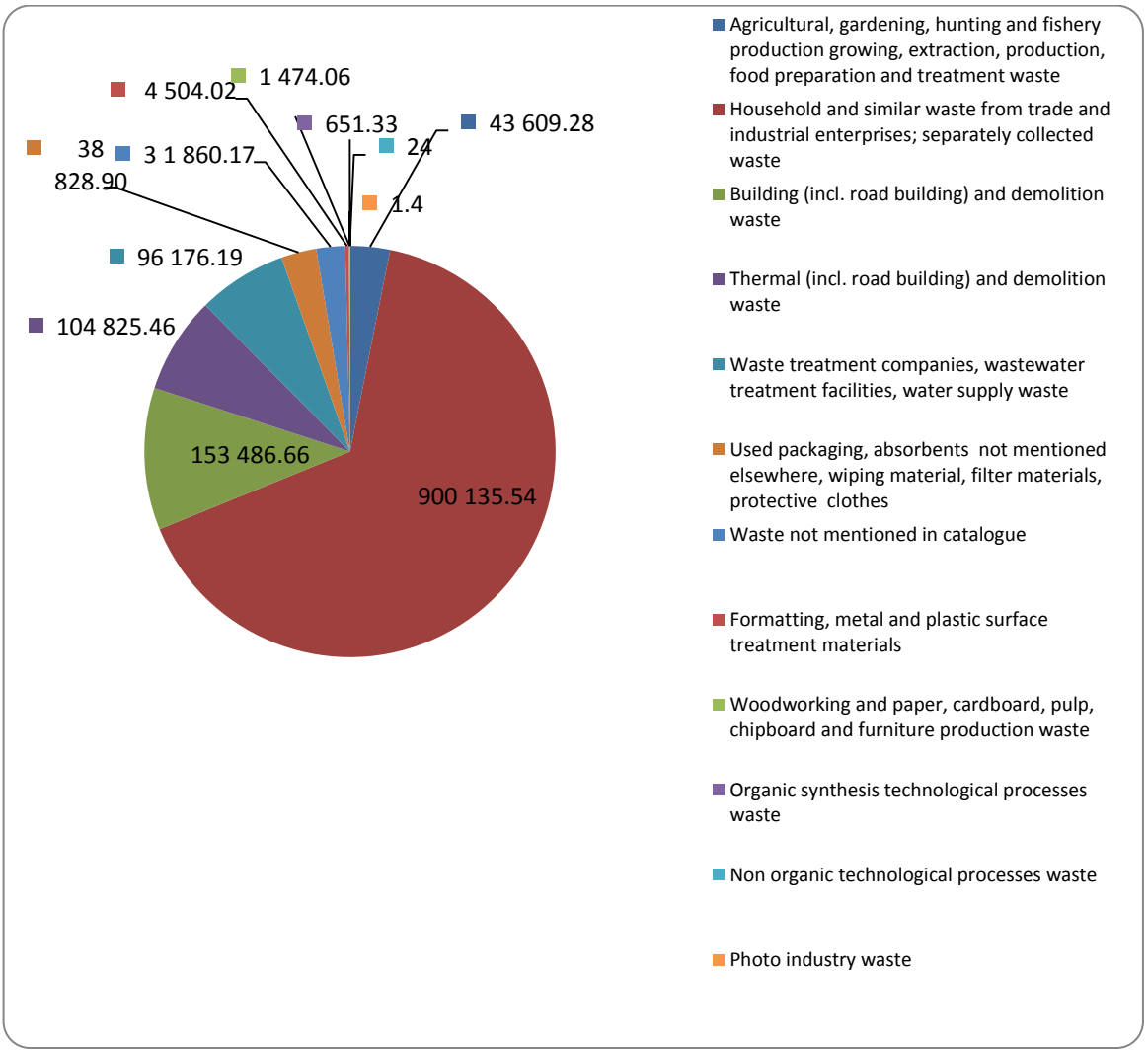

Fig. 2. The amount of collected waste in Latvia in 2010, in tons

2.2 Municipal waste management in the country

There are ten regional waste management regions in Latvia, each of them having a municipal waste landfill site. Disposal of waste is allowed only in waste landfills; the last dump sites were closed in 2011.

Fig. 3. Latvia's waste management regions and waste disposal landfills

The first waste management landfill was put into operation in 2005 (Greater Riga regional municipal waste disposal landfill „Getliņi"), the last of the 11 landfills „Dziļā vāda" in Vidusdaugava waste management region was put into operation in 2011.

Latvia does not have a highly developed separate bio waste collection and treatment system. The only method mentioned in Latvian legislation for minimising the amount of bio waste and bio waste treatment is composting. During the development process of the waste management system several solid waste disposal landfills in Latvia established composting facilities (see Table 2.1). The aim of the composting facilities was to minimise the amount of bio waste to be deposited in the country; however, practical experience shows that these composting areas are not being used to their full potential. Taking into consideration all the above mentioned, it is necessary to introduce alternative methods for minimising the amount of bio waste deposited in the landfills.

Table 2.1. Composting system in Latvian landfills.

Name	Composting area space (m^2)
Križevnieki	2000
Cinīši	1050
Ķīvītes	-
Kaudzītes	2000
Janvāri	5038
Getliņi	-
Pentuļi	-
Dziļā vāda	14000
Brakšķi	-
Grantiņi	-
Daibe	5632

Waste management in the country is regulated by the Waste Management Law. In accordance with this law the waste management in the state is carried out according to the Waste Management State Plan and the regional waste management plans. Waste management plan for 2006 – 2012 envisages a series of measures to be implemented in the given time period regarding biodegradable fraction which would improve the waste management situation in the country. Looking back on the progress we may conclude that the measures have partly been fulfilled, for instance, natural resource tax on biodegradable municipal waste disposal in landfills has been raised, and local government binding regulations have been supplemented with a new section on biodegradable municipal waste management. At the same time it should be noted that there are many unsolved issues hampering biodegradable waste treatment and its efficient use.

Currently the largest part of municipal and similar waste from trade and industrial enterprises and institutions, as well as separately collected waste are deposited in the landfills (see Figure 4)

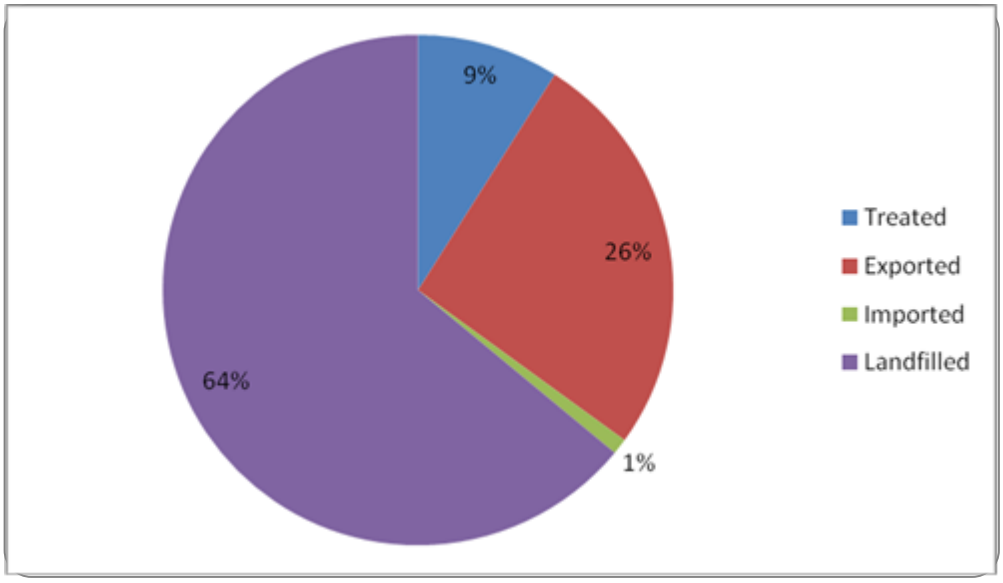

Figure 4. Unsorted waste management, year 2010

According to the statistical data 64% of all the collected municipal and residual waste, including the biodegradable fraction and packaging, were deposited in the solid municipal waste landfills in 2010 in Latvia.

To minimise the deposited amount of waste, there will be changes in the waste management system in the coming years. The Waste Management Law requires that waste should be subject to treatment before it is landfilled.

2.2.1. Municipal waste management in the local governments: regulatory issues

Local governments are responsible for organisation of waste management in their administrative territories in Latvia. In accordance with the Waste Management Law the local governments:

1. organise the management of municipal waste, including municipally produced hazardous waste, in conformity with the State Waste Management plan and regional plans within the administrative territory;
2. issue binding regulations regarding the management of municipal waste within the administrative territory, determine the division of such territory into municipal waste management zones, the requirements for the waste collection, transport, reloading and storage, as well as the procedures by which payments for such waste management should be made; organise separate waste collection within the administrative territory [2].

Valmiera Municipality has issued Binding Regulations No. 119 “On Waste Management in Valmiera City”.

The Regulations state that waste producers are allowed to compost biodegradable waste in the territory of their property unless it creates a threat to human health, life, environment or a third person’s property.

In accordance with the binding regulations the residents of Valmiera and legal entities of Valmiera City operating in Valmiera City administrative territory, are prohibited of any actions which may cause environmental pollution or contradict requirements of the regulatory acts.

Valmiera City residents are granted a possibility to participate in the waste separation system or using other services offered by the waste manager: separate waste collection system at purpose-built separate waste collection areas (ECO stations), points (ECO points), or points or biodegradable waste collection systems by getting involved in waste manager’s campaigns.

Separately collected household waste (paper, metal, glass, plastic), biodegradable waste, as well as household hazardous waste and environmentally dangerous goods should be collected and stored separately. Sorting should be performed according to requirements set by the waste manager regarding separate waste collection.

As regards biodegradable waste collection at grocery shops and public catering places, there should be a separate contract [3].

Waste producers engaged in agricultural (food) production or processing, food trade, and public catering services are obliged to provide separate collection of biodegradable waste which is produced as the result of their commercial activity, they should conclude a contract with a waste manager for removal of the waste, and comply with the manager’s requirements regarding management of such waste. Storage of biodegradable waste should be performed in such a way that it ensures inaccessibility to the container by a third person. Currently SIA “ZAAO” has concluded such contracts of waste management with the local entrepreneurs in 14 places in Valmiera City, but there is no exact information available regarding other waste managers that possibly provide waste management to retail establishments (supermarket chains) and food production companies. From publicly available information one can conclude that the agricultural farm “Zemturi” provides these services to some industrial bio waste producers, and that some supermarket chains use services of SIA “Recikls”

2.2.2. National goals regarding bio waste management

In accordance with the Directive No. 1999/31/EC On the Landfill of Waste (further in the text: Directive 1999/31/EC), waste is regarded as biodegradable if it is capable of undergoing aerobic or anaerobic decomposition, such as food waste, park and garden waste, paper and paperboard. In compliance with the Directive No. 1999/31/EC “municipal waste” means waste from households, as well as other waste, which, because of its nature or composition, is similar to the waste from household.

In accordance with the Directive No. 1999/31/EC, Article 5, Paragraph 1, Member states shall set up a national strategy for reduction of biodegradable waste going to landfills. This strategy should include measures to achieve the targets set out by the Directive, by means of recycling, composting, biogas production or materials/energy recovery. The targets set out Article 5, Paragraph 2 of the Directive No. 1999/31/EC, are included in Annex I of this plan. Member States which in 1995 or the latest year before 1995 for which standardised EUROSTAT data is available put more than 80% of their collected municipal waste to landfill may postpone the attainment of the targets by a period not exceeding four years. Member States intending to make use of this provision, inform EC of their decision.

According to the Waste Management Law biodegradable waste is any degradable waste from gardens and parks, households, restaurants, public catering establishments retail premises selling food; it is kitchen waste and other similar food production waste.

Waste Management State Plan and regional plans set out measures which promote the use of environmentally friendly materials manufactured from bio waste, separate collection of biodegradable waste for recovery, composting, treatment, as well as measures for biodegradable waste treatment. Biologically degradable waste is composted in waste landfills or specially equipped places for composting biodegradable waste. .

To meet the requirements of the Directive No. 1999/31/EC the following amount of biodegradable waste may be disposed of in waste landfills in Latvia (Table 2):

Table 2. Amounts of biodegradable municipal waste to be deposited [4]

Year	Estimated production of biodegradable municipal waste, tons	Amount of biodegradable municipal waste to be accepted for disposal in the landfill, tons	Amount of biodegradable municipal waste not acceptable to be disposed of in the landfill, tons
2010	607 000	345 000	262 000
2013	632 000	230 000	402 000
2020	691 000	161 000	530 000

2.2.3. Existing applicable technologies for bio waste management

Currently the bio waste management system is not highly developed in the country. The total amount of waste during the period of economic recession of 2008-2010 has decreased and stabilised in 2011, especially the amount of industrial waste. In the course of time, however, unless Latvia does not experience a rapid economic development, the fact which does not have any objective reason, the problem of disposable biodegradable waste may become acute from the perspective of the directive requirements.

At present Latvia basically carries out composting of biodegradable waste in open windrows. The method is simple and cheap for operation, but the obtained material, even though it most often corresponds to the defined quality requirements, is not highly demanded on the market, therefore it is used mainly (if ever) for remediation of dumpsites and quarries, less frequently for greening towns (Alūksne, Ventspils u.c.).

Building of composting facilities in landfills has not fulfilled expectations up to now. The main reasons are:

- **Amount and composition of bio waste,**
- **the prepared material is not demanded on the market,**
- **lack of administrative requirements and control for enforcement of bio waste services.**

This problem is well known in other EU countries as well where the compost most often is offered free of charge. One of the possible solutions for boosting the compost market could be mandatory use of the material for remediation of different territories, providing the requirement in MK regulations, for instance, recovery of degraded areas.

Another solution is the use of biodegradable waste in bioreactors. Currently biodegradable waste is not used in bioreactors in waste management regions; however, biodegradable waste in bioreactors is used in wastewater treatment plants in Riga, in an alcohol distillery in Krāslava and a beer brewery in Cēsis City.

Some SMW landfills produce biogas from biodegradable waste. Biogas is produced in the landfills "Getliņi", "Ķīvītes", "Daibe" and the closed dumpsite "Šķēde". The process is economically profitable. At present unfortunately the generated heat is not used efficiently. Generation of heat would have a positive effect on waste tariffs.

Research has proved that in 10 out of 11 Latvian landfills biogas production is highly profitable (except landfill "Grantiņi" where the generated amount is too small).

2.3 Municipal waste management in Valmiera City

The amount of SMW deposited in Daibe landfill in the year 2011 is given in Table 3. (See Table 3):

Table 3. Amount of deposited waste in 2010

Waste type	Type classification code number	Amount, tons
Unsorted municipal waste	200301	16461,80
Sludge form wastewater treatment plants	101199	1351,34
Construction waste	170904	110,53
Asbestos containing building materials	170605	386,90
Bulk waste	200307	5965,84
Wastewater treatment sludge	190805	213,11
Other waste from wastewater treatment plants	190899	30,59

Amount of waste accepted at SMW landfill Daibe in 2011 (Table 4):

Table 4. Amount of accepted waste in 2010

Waste type	Type classification code number	Amount, tons
Municipal wastewater treatment sludge	190805	2015,54
Discarded tyres	160103	434,87
Bulk waste	200307	4768,86
Compostable materials	200201	8920,30
Construction waste	170904	2782,13
Construction waste	170107	437,54 t
Separately collected waste	150106	3318,45
Wooden packaging	150103	336,78
Furnace ash	100101	311,38

Separately collected waste in Valmiera City is shown in Table 5. The total amount of unsorted municipal waste in 2011 was 64062 m^3; consequently, only 0.175% of the total amount is separately collected bio waste.

Table 5. Amount of separately collected bio waste in Valmiera City

Year 2010	Year 2011
115. 68 m^3	111.84m^3

Table 6 shows legal persons using biodegradable waste collection services in Valmiera and its neighbourhood.

Table 6. Clients of biodegradable waste collection services

Company name	Address
SIA „Agroserviss Valmiera"	Agroserviss, Kauguru pag.
Valmiera Vocational Secondary School	Vadu 3, Valmiera
Valmiera Nursing Home	Kauguru 3, Valmiera
SIA „Valker"	Tērbatas 16a, Valmiera
SIA „Neldi"	Brīvības 2, Valmiera
SIA „P2"	Raiņa 14, Valmiera
SOS Children's Village Latvia	Ganību 3, Valmiera
SIA „Lietas MD"	Salacas 1a, Valmiera
SIA „Palink"	Rīgas 4, Valmiera
Valmiera Nursing Home	Rīgas 55, Valmiera
Valmiera Vocational Secondary School	Ausekļa 25c, Valmiera
SIA „Vidzeme Regional Hospital"	Jumaras 195, Valmiera
SIA „Salvis"	V.Baloža 11d, Valmiera
SIA „Vidzeme Olympic Centre"	Vaidavas 15, Valmiera

The total amount of collected biodegradable waste in 2011 is indicated in Table 7. The total amount of collected biodegradable waste and separated from municipal waste in 2011 accounts for only 11000 tons a year. Consequently, the amount of waste to be treated and used for biogas production is 11000 tons a year.

Table 7. Amount of biodegradable waste collected in North Vidzeme in 2011

Types of waste	Amount, tons
Biodegradable waste separated from municipal waste during pre-treatment	8920.30
Wastewater treatment sludge	2015.54
TOTAL	10935.84

The calculated annual amount of waste produced by one waste producer (natural person) is:

- 1.5 m^3 or 0.3 t in Cēsis and Valmiera Cities;
- 1.2 m^3 or 0.24 t in other regional towns;
- 0.85 m^3 or 0.17 t in rural territories, including villages.

The company has carried out a forecast of the amount of biodegradable waste for the coming years. The calculation of the biodegradable waste is done considering possible NDP changes and the demographic situation (see Table 8).

Table 8. Forecast of the biodegradable waste [5]

Waste, tons annually	2012	2015	2018	2020
Amount of biodegradable waste separated at waste pre-treatment centre, tons	5785	7213	8140	8486
Separately collected green waste	3020	3071	3103	3125
Wastewater treatment sludge	3886	3951	3993	4021
Total forecasted amount of biological waste	**12691**	**14235**	**15236**	**15632**

The forecast shows that the amount of biodegradable waste available for efficient use in 2020 could increase by 50% compared to the amount of 2011 and will account for 15000 tons of bio waste a year.

2.3.1. Description of municipal waste management system

Company ZAAO, Ltd. provides municipal waste management services within ~ 10411 km^2 large area, including:

- Rural territories – 98.7%
- Urban territories – 1.3 % (14 towns/cities)

Population ~ 186 000 people, including:

- rural ~ 103 000
- urban ~ 83 000.

Figure 5. ZAAO, Ltd. management territory

Municipal waste management in North Vidzeme Waste Management Region is offered by the following commercial companies:

- ZAAO, Ltd.;
- Jumis, Ltd;
- L&T, Ltd..

2.3.2. Waste collection system

More than 26 658 SIA "ZAAO" waste collection containers are used for waste collection. 22 180 containers with a capacity from 0.12 till 0.24 m^3 are used for waste collection from private homes and smaller companies. 3858 containers with a capacity of 1.1 m^3 are used for collection of waste from apartment buildings, companies and public institutions.

Bulk waste, demolition and construction waste is collected in 124 containers with a capacity of 2.5 till 30 m^3.

880 publicly available press containers with a capacity of 1.1 m^3 are used for packaging waste up to 30 m^3 at points of sale.

Waste collection frequency in regional towns depends on the types of containers (above-ground, underground, capacity, a.o. factors) and the amount of waste production. In towns it is usually 5 times a week. Every year "ZAAO" gradually invests in underground container collection system near apartment buildings in the largest Vidzeme cities, thus increasing the waste collection intervals and decreasing GG emissions, caused by waste collection transport, noise level in cities and the amount of fuel for waste collection transport. The frequency of waste collection is chosen by the waste producer (household, property maintenance manager, company) by negotiating contract terms and conditions and the provided container capacity with the waste management company.

2.3.3. Separate waste collection

Separate waste collection is a process which requires a multicomponent system for collection of separate fractions, which are then directed to recycling/ reuse.

Currently separate waste collection system is being intensively developed. Sorted waste is collected in 15 sorting stations, located in regional towns. Two sorting stations are located in Valmiera City.

ZAAO, Ltd. regularly organises campaigns, for instance, temporary containers are placed for collection of specific waste (glass, paper/cardboard, PET bottles). Such campaigns are organised both in cities and in rural territories – villages.

Valmiera City has a developed separate waste collection system. Residents and legal persons are offered different possibilities for participation in separate waste collection. They may use services of an ECO station and ECO points. In addition to this, different attractive solutions are offered promoting separate waste collection, for instance, services of an eco-box and an eco-bag.

Figure 6. „ECO-box" and „ECO-bag"

ECO-box is a service available to apartment building residents. ECO-boxes are intended for collection of advertising booklets and the press editions; they are placed in staircases of apartment buildings next to the letter boxes.

ECO-bag – for more convenient sorting. This service was offered to the owners of private homes in Valmiera City. ECO-bag is for paper and cardboard waste, PET bottles, polyethylene waste and metal waste.

The total amount of separate waste collection services is given in Table 9.

Table 9. Separate waste collection offers in Valmiera City

Separate waste collection offers in Valmiera City	Amount
ECO-box	112
ECO-bag	78
Containers in schools	19 schools
Separate waste collection for retired people:	
Packaging	70 containers
PET	25 containers
Glass	37 containers
Hazardous waste	6 containers
Separate waste collection for legal persons	
Packaging	102 containers
Glass	15 containers

3. Technical preconditions for implementation of bio waste management system management

3.1 Bio waste collection system

Two scenarios are explored for biodegradable waste collection. The chosen bio waste scenario determines its further treatment possibilities.

1. **"Unsorted municipal waste collection (baseline) scenario"**

„The baseline" scenario provides the use of the existing waste collection and transport system for unsorted municipal waste, and the regional waste landfill in Daibe. In addition gradual implementation of separate biodegradable waste collection is planned for legal persons, provided, there are relevant normative regulations for this purpose.

2. **"Separate waste collection scenario"**

Provided, the development and implementation (2013-2020) of the state waste management policy create the necessary administrative and economic preconditions, then it is possible to introduce packaging and bio waste separate collection both for natural and legal persons. Under the current market conditions economically more justified is establishing of separate collection for packaging waste, as there exists a functioning market for secondary raw materials in Latvia, and there is also a possibility to export it to neighbouring countries. Separate collection of packaging waste may be negatively influenced by the plan of the Ministry of Environmental Protection and Regional Development to impose the deposit system in packaging.

The cost of separate bio waste collection for customers will depend on the potential state and EU Structural Funds' support to separate waste collection as well as on obtaining the technological facilities for treatment. At any case, the current calculations and assumptions prove that development and maintenance of such a system in rural territories will be economically unjustified. Expenses of consumers and waste managers may substantially increase while it is not predictable how the total amount of the collected waste increases. The specific costs for waste collection per one unit of mass/ volume will increase for the waste managers.

In medium term the 1st scenario may be considered as economically the most viable. The most essential obstacles for introduction of the 2nd scenario are: payment increase for waste producers, waste managers' additional expenses for installation of new separate collection containers, and increase in waste collection transport costs.

3.2 Bio waste treatment technologies/ solutions

RWMC Daibe operates 1st waste mechanical pre-treatment centre in Latvia equipped with mechanical shredder and screener. The pre-treatment line consists of the shredder – model from company "Komptech" –Terminator mobile 3400S F – throughput performance up to 50 t/h; drum rpm.0-50 mm; the screener (star screen) – model of Komptech Multistar L3-Flowerdisc – throughput performance up to 180 m^3/ h with screen sections: 0/10...25 mm; 10...25 /60...80 mm; >60...80 mm. Schematic view of the mechanical pre-treatment process in landfill Daibe is presented by figure 7 [7].

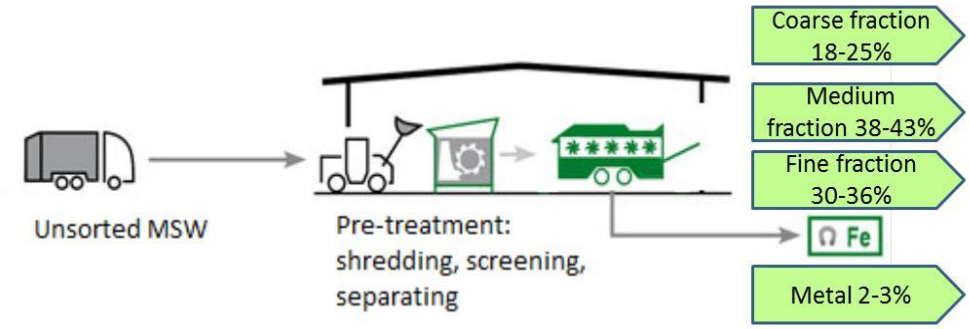

Figure 7. The mechanical pre-treatment process in the landfill Daibe

ZAAO together with VIRSMA, Ltd has performed MSW sampling according to the Standard LVS CEN/TR 15310-(1-5):2007.

The following parameters: moisture, heating value, chlorine and sulphur content, ash, amount of heavy metals was determined according to the series of Standards - Characterization of waste.

The average percentage distribution of the waste content is shown in the Table 10.

Table 10. Average value of waste fractions (in summer) (% of dry mass) [7]

Content of Waste	Coarse Fraction*	Medium Fraction*	Fine Fraction*
Paper and cardboard	46.1±8.87	28.3±4.11	1.6±0.50
Plastic	35.5±7.75	25.4±3.93	0.9±0.18
Small particles, putrescible	3.7±1.01	14.1±2.98	73.0±5.55
Hygiene (diapers and pads)	3.3±2.24	2.0±0.75	0
Textile	3.7±3.39	0.7±0.31	0
Rubber	6.2±4.25	5.2±2.54	0
Wood	0.01±0.04	4.9±1.91	0
Metal	1.2±0.86	2.9±0.84	0.02±0.02
Glass	0	8.3±1.96	20.3±4.46
Mineral	0.02±0.02	8.1±3.42	4.2±1.58

*Mean value and standard error

The content of coarse fraction is characterized by relatively large amount of (46 %) paper and cardboard and by 36 % of plastic (both predominantly as packaging); there is no glass waste.Samples of this waste fraction contained large waste: foot wear, magazines, half of bucket. According the data represented by the table 11, this fraction is the most responsible to the demands for refuse derived fuel (RDF). It contains less humidity and hazardous components (heavy metals and chlorine).

Table 12 contains average results of laboratorial analyses [7]

Table 4. The average parameters of waste samples (in summer) (for dry mass)	Coarse fraction	Medium fraction	Fine fraction
Lower Heating Value (as received) MJ kg^{-1}	13.22±0.2	10.56±0.2	6.65±0.2
Upper Heating Value (Dry basis) MJ kg^{-1}	25.70±0.2	23.67±0.2	16.49±0.2
Ash content (dry basis) (%)	16.8±0.1	14.9±0.1	22.1±0.1
S (%)	0.21±0.1	0.27±0.1	0.34±0.1
Cl (%)	1.1±0.1	4.1±0.1	2.0±0.1
Mercury (dry basis) mg kg^{-1}	0.50	0.45	0.66
Cadmium (dry basis) mg kg^{-1}	0.84	0.75	1.11
Thallium (dry basis) mg kg^{-1}	0.34	0.30	0.44
Bromine (dry basis) M.-%	0.023	0.006	0.002
Iodine (dry basis) M.-%	0.001	0.001	0.001
Antimony (dry basis) mg kg^{-1}	5.376	5.811	0.663
Arsenic (dry basis) mg kg^{-1}	0.504	0.447	1.326
Chromium (dry basis) mg kg^{-1}	11.76	13.41	13.26
Cobalt (dry basis) mg kg^{-1}	1.68	1.49	2.21
Copper (dry basis) mg kg^{-1}	28.56	35.76	24.31
Lead (dry basis) mg kg^{-1}	60.48	62.58	16.35
Manganese (dry basis) mg kg^{-1}	47.04	87.91	112.71
Nickel (dry basis) mg kg^{-1}	5.04	4.47	8.84
Tin (dry basis) mg kg^{-1}	1.68	35.76	4.42
Vanadium (dry basis) mg kg^{-1}	8.4	7.45	22.1

The content of medium fraction is characterized by large waste diversity. The combustible part forms overall about 82 % of the waste of medium fraction. It is possible to increase the lower heating value of the medium fraction by using drying or biological pre-treatment followed by mechanical pre-treatment.The content of fine fraction is characterized by **biologically degradable material** (average 70 %): kitchen stuff, green waste from gardens and parks, partly decomposed paper and small particles (as sand and other material which cannot be defined without chemical analyses), as well as about 27 % of glass, ceramic and stones; with no hygiene, textile, rubber, wood waste. As the level of contaminants is high, it cannot be used as compost material. After bio treatment and stabilization it can be used as covering material. The mean values of the moisture for all fractions are represented by Table 12.

Table 12 Mean values of moisture (%) of waste fractions in three seasons [7]

Waste Fraction	In Summer	In Autumn	In Winter
Coarse fraction	42.9	36.1	35.5
Medium fraction	49.2	47.7	43.4
Fine fraction	49.0	44.2	48.9

Referring to the above mentioned data about collected MSW amounts and composition, all the technological solutions provided by this concept, are planned for implementation at RWMC "Daibe". The main arguments for the chosen location:

- Valmiera City bio waste amount is insufficient for economic development of independent bio waste treatment facilities.
- RWMC “Daibe” territory possesses all the necessary operational pollution permits and permits for installation of facilities.
- Bio waste final treatment product which constitutes ~95% of the initial mass, has practical application as cell covering material in the landfill.
- Biogas co-generation facility is already in operation in RWMC “Daibe”; it generates the necessary heat for bio waste treatment.
- Municipal waste mechanical pre-treatment facility is already in operation in RWMC „Daibe” [7].

3.2.1. Scenarios for biowaste treatment

1. “Baseline scenario”

The “baseline scenario” provides mechanical pre-treatment of unsorted waste at Daibe landfill regional waste treatment centre by using previously created infrastructure. In the baseline scenario the result of the pre-treatment would be bio waste inert waste mix fraction which is composted in the existing composting facility, and the achieved material is used for placing in the landfill cell as an intermediate cover.

The given bio waste treatment process does not provide for efficient minimisation of GGE, energy is not recovered, the treatment process does not provide maximum economic added value.

2. Centralised bio waste anaerobic fermentation with high content of dry matter

As the result of centralised bio waste anaerobic fermentation with high content of dry matter the amount of waste organic dry matter is decreased, and as a by-product biogas is generated. Initially the generated bio gas may be used in bio gas co-generation facility at the SMW treatment centre of Daibe landfill for energy and heat recovery.

The anaerobically fermented waste organic fraction will be further stabilised and mixed with ballast mass and used for waste disposal cell intermediate cover. With potential change of economic pre-conditions it is possible to purify biogas and compress it, and further use in specially adapted vehicles (waste collection transport, public transport).

3. Centralised bio waste anaerobic fermentation with low content of dry matter

In case the state waste management policy development (2013-2020) and implementation create the necessary administrative and economic pre-conditions; it is possible to develop a separate bio waste collection system from natural and legal persons.

Service tariffs for separate bio waste collection for customers will depend on the potential state and EU Structural Funds support to such an activity. At any case, the current calculations and assumptions prove that development and maintenance of such a system in rural territories will be economically unjustified.

Expenses of consumers and waste managers may substantially increase while it is not predictable how the total amount of the collected waste increases. The specific costs for waste collection per one unit of mass/ volume will increase for the waste managers.

From the technological point of view the contents of waste from households and bio waste similar in composition contains high content of dry matter (30-40%), variable composition, different packaging and other waste mix, which adds to the cost of its preparation process for anaerobic digestion in fermenting facilities.

In order to use such digestate or compost in agriculture, stringent waste composition control is necessary, as well as pasteurisation before its input into fermentation facilities, so as to provide elimination of pathogenic organisms.

Bio waste collection and treatment scenario comparison is given in Table 13.

Table 13. Comparison of alternatives

Criterion	**Comparison of alternatives**		
	1. alternative	**2. alternative**	**3. alternative**
Waste collection	Unsorted waste collection „basic scenario"	Unsorted waste collection + separate waste collection	Separate waste collection
Waste treatment	Mechanic pre-treatment and composting	Mechanic pre-treatment and anaerobic digestion (with high contents of dry matter)	Anaerobic digestion (with low contents of dry matter)
ECONOMIC:			
Investment costs	Additional costs not necessary	1 100 000,00 Ls	1 257 600,00 Ls
Operational costs			
Impact on waste management tariffs	Current tariffs 8,13 Ls/m^3	Current tariffs 8,13 Ls/m^3	Potential tariffs 10,7 Ls/m^3
TECHNICAL:			
Bio waste treatment share in the total municipal waste flow;	30%	30%	100%
Energy consumption/ generation balance	Energy recovery not provided	Energy recovery provided	Net energy recovery provided
Necessary building area	Additional building area not necessary	~ 0.06 ha	~ 0.08.ha
OPERATION/ RISKS:			
Bio waste availability	Bio waste available	Bio waste available	Bio waste available
End product quality	Medium quality	Medium quality	Good quality
End product market demand	Use in landfill	Use in landfill	Use in landfill
Experience in operational method	Sufficient experience	Sufficient experience	Sufficient experience
Waste producers' involvement	Not necessary	Limited involvement necessary in waste sorting process	Active overall involvement necessary in waste sorting process
ENVIRONMENTAL:			
GGE-related / saved emissions	+18 -14 kg/CO2e/t	-162 to -215 kg CO2e/t	-162 to -215 kg.CO2e/t
Air quality	Not improved	Improved	Improved
Water quality	Insignificant	Insignificant	Insignificant
Noise emissions	Insignificant	Insignificant	Insignificant
Odour emissions	Significant	Inessential	Inessential
Transport	Inessential	Inessential	Significant
Resource consumption	Inessential	Inessential	Significant
POLITICAL:			
EU and LR waste policy goals	Achieved partially	Achieved	Achieved
EU and LR energy and climate policy goals	Achieved partially	Achieved	Achieved
Provision of environmental quality	Provided	Provided	Provided
Public acceptance	Insufficient	Yes	Yes
Impact on employment/ regional development	Unaffected	Positive influence	Positive influence
Public involvement	Not necessary	Partially necessary	Necessary
Environmental monitoring	Provided	Provided	Provided

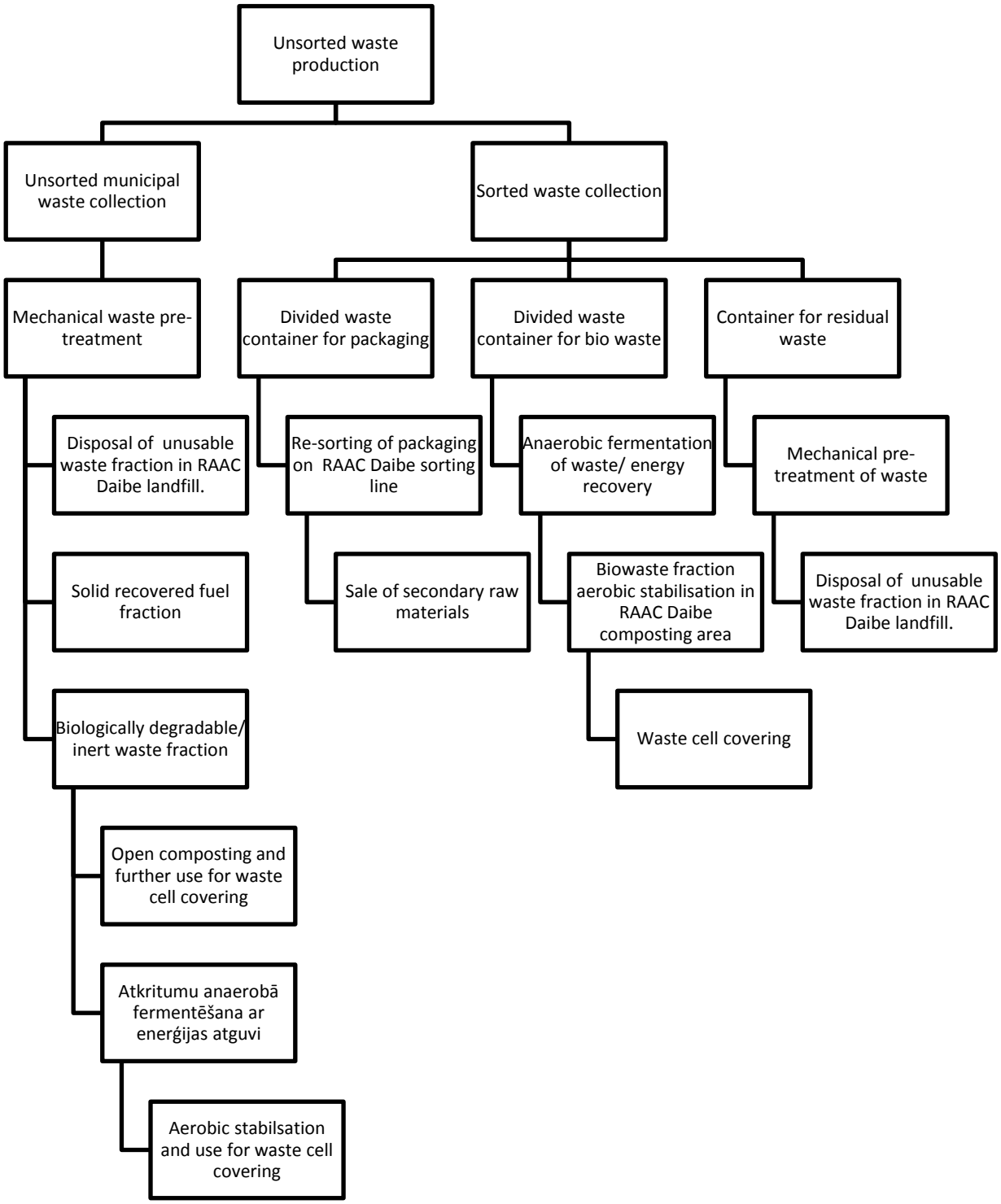

Figure 8. Alternative processes' flowchart of municipal waste collection and treatment

4. Economic and organisational considerations

4.1 Legislative framework/ amendments necessary for implementation of the bio waste management system

It is necessary to incorporate requirements regarding introduction and maintenance of biological waste management system in the State environmental, agricultural and energy policy planning and regulating normative acts. The state institutions should create aggregate measures of normative, fiscal and monetary policy which would motivate waste producers to participate in the waste management system; municipalities to administer waste management in their territories, and waste managers would be stimulated to provide efficient waste collection and treatment.

Regional and local planning documents and binding regulations should require implementation of requirements defined in the waste management plan, providing centralised management of biodegradable waste.

4.2 Bio waste management system business model

To provide successful introduction of a biodegradable waste management model, it is necessary to ensure efficient cooperation of all stakeholders: waste producers, waste managers, municipalities and environmental monitoring institutions.

Valmiera biodegradable waste treatment plans to use anaerobic fermentation process with high content of dry matter, or the so called “dry fermentation”. It is possible to use waste with lower moisture content and higher impurity content in the dry fermentation bioreactor. “KOMPOFERM” fermentation facility is being planned as the optimal technical solution.

Table 14. Necessary investments

Necessary investments	LVL, without VAT
Site preparation, local engineering	17 570
Bearing constructions	224 897
Technological equipment	768 692
Biogas emergency torch	10 191
Technological equipment supply costs	2 811
Equipment start-up/ control/ training	2 811
Cost contingency reserve (5%)	51 349
TOTAL	1 078 321

5. Stakeholders of the waste management system

Close cooperation among the regional waste manager, municipal and regional environmental authorities is essential for the development of waste management system. Such cooperation will facilitate more active participation of companies in separate bio waste collection.

To provide separate biodegradable waste collection services to natural persons, close cooperation is essential among the waste manager, non-governmental organisations and educational institutions. Such cooperation will facilitate enhancement of environmental awareness and promote a faster start of separate biodegradable waste collection from natural persons.

6. Concept of Bio Waste and Bio Methane Use for Valmiera City

6.1 Introduction/ improvement of biodegradable waste collection system

Biodegradable waste collection system consists of unsorted municipal waste collection and further separation of biodegradable waste in the waste pre-treatment centre and from separate bio waste collection from legal persons. Considering previously evaluated alternatives and the offered "**Unsorted Municipal Waste Collection (Baseline) Scenario"**, in medium term only separate bio waste collection is provided for legal persons, the activity of which leads to production of biodegradable waste: public catering companies, food shops, food processing and production companies. Specially marked 240 l containers with 300 l bag inside are provided for collection of bio waste.

Figure 9. Container for bio waste

It is allowed to dispose of the following waste in the bio-waste containers:

- biodegradable waste, e.g., food waste, discarded food products;
- milk production waste;
- meat, fish and other animal food product production and treatment waste.

It is forbidden to dispose of the following waste in the bio-waste container:

- plastic, glass and tin packaging, and other unsorted household waste;
- food oils and other liquids.

6.2. Concept of bio methane use for Valmiera City

Taking into consideration that as the result of the privatisation process the company JSC "Latvian Gas" has secured a monopoly until 2017, and due to physical limitations of pipelines, independent producers may not supply gas through JSC "Latvian Gas" network infrastructure until 2017.

The forecasted RWMC "Daibe" biogas generation capacity from bio waste is too small, in the medium term it would be economically more profitable to purify biogas to the quality of bio-methane, and build a local gas grid for potential users. In more distant future, if the total amount of biogas generation increases up to ≥500 Nm3/h, it is possible to review biogas purification and compressions in container-type reservoirs and further transportation to a potential biomethane/ natural gas filling station or natural gas co-generation station in Valmiera City.

The first candidates as potential bio-methane users would be the public passenger carrier - VTU Valmiera, Ltd. and ZAAO, Ltd. waste collection transport.

Anaerobic fermentation station planning, construction, operation and bio methane generation and use will be described in detail in the Concept of Bio Methane Management for Valmiera City.

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