LATVIAN JOURNAL OF PHYSICS
AND TECHNICAL SCIENCES
2024, N 5

DOI: 10.2478/lpts-2024-0035

COMPARATIVE STUDY OF WASTE MANAGEMENT AND SAMPLING PRACTICES IN LATVIA AND ESTONIA

L. Zemite[1,2]*, A. Backurs[1,3], K. Vonda[4], S. Batjuskovs[5],
P. Cnubbern[6], L. Jansons[1,7]

[1]Latvian Hydrogen Association,
1 Akademijas Square, Riga, LV-1050, LATVIA
[2]Riga Technical University,
Faculty of Computer Science, Information Technology and Energy,
12-1 Azenes Str., Riga, LV-1048, LATVIA
[3]Latvia University of Life Sciences and Technologies,
Faculty of Engineering,
5 J. Cakstes Blvd., Jelgava, LV-3001, LATVIA
[4]Ltd. Getliņi EKO,
57 Kaudzisu Str., Rumbula, Ropaži parish, LV-2121, LATVIA
[5] Ernst & Young Baltic,
1A Muitas Str., Riga, LV-1010, LATVIA
[6]Hydrogen Architects,
9728 RJ Groningen, THE NETHERLANDS
[7]Riga Technical University,
Faculty of Engineering Economics and Management,
6 Kalnciema Str. 210, Riga, LV-1048, LATVIA
*e-mail: prof.zemite@gmail.com

The study focuses on waste management and sampling practices carried out in two large Baltic cities: Riga (Latvia) and Tartu (Estonia). Even though waste collection schemes are not at the same centralisation level in the two municipalities, certain similarities can be observed in waste collection, management and sampling processes. Governed by provisions of Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste, general national waste treatment legislation, and the national waste management plans, waste management practices in Latvia and Estonia are moving towards minimalisation of waste landfilling and maximalisation of waste inclusion into various recycling practices (use in waste biodegradation cells, bioreactors, different waste recycling facilities, in developing modern waste management supporting infrastructure, etc.). Therefore, waste management in two countries can be partly characterised as a vital element of emerging circular economy activities aimed at minimising landfill deposition of waste, hence, a more effective and permanent approach to sustainable waste management problems, on the one hand, and maximising the diversified use of waste in different branches of economy, hence, larger economic and social benefits.

Keywords: *Getlini, Tartu, waste management, waste processing, waste sampling.*

1. INTRODUCTION

The management of waste is a growing concern globally, regionally and nationally. In 2020, the total waste generated in the EU amounted to 2 135 million tons or 4 815 kg per capita. Only 39.2 % of waste was recycled and 32.2 % landfilled [1].

However, the traditional method of disposing of waste in landfills is no longer deemed sustainable due to the impact it has on the environment. Waste management facilities need to move towards a more sustainable and circular approach to reduce the amount of waste that is landfilled and to minimise the environmental impact of waste management [2], [3]. There is a need for innovative solutions that utilise new technologies and business models to create a more sustainable waste management system [4], [5].

This goes in line with the target set by Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste (Directive 1999/31/EC) to take the necessary measures to ensure that by 2035 the amount of municipal waste landfilled is reduced to 10 % or less of the total amount of municipal waste generated (by weight) [6].

In line with provisions of Directive 1999/31/EC, Latvia adopted the National Waste Management Plan for 2021–2028 [7], so the effectiveness of waste prevention measures can be evaluated based on the following quantitative indicators, which by substance are comparable to aims for 2028 (see Table 1).

Table 1. Quantitative Indicators for Evaluation of Effectiveness of Waste Prevention Program in Latvia

No.	Quantitative indicators	Measurement	2018	2028
1	Total volume of household waste produced by households	kg per capita	409	<400
2	Total volume of household waste	t/year	785 074	<600 000
3	Total volume of produced hazardous waste	t/year	118 142	<50 000
4	Total volume of recycled household waste	% of total volume	43	55
5	Total volume of recycled hazardous waste	% of total volume	31	75
6	Total volume of recycled production waste	% of total volume	83.3	85
7	Total volume of household waste that is landfilled	% of total volume	58.9	< 40
8	Total volume of production waste that is landfilled	% of total volume	5	< 25 %
9	Total volume of hazardous waste that is landfilled	% of total volume	4.5	< 25 %

Source: [7]

The plan focuses on the increase of recycling level of each waste type, especially household and hazardous waste. However, at the European Union level, the Latvians still sort too little. For example, in 2021, Latvia had to pay EUR 15 million in sanctions for its small amount of recycled plastic. This would account for a similar amount in 2022. Every resident of Latvia will pay approximately EUR 8 per year for this. State audit warns that Latvia could also be faced with an additional EUR 11 million penalty for the insufficient collection of biodegradable waste (BDW) [8].

Also, in Estonia goals are determined in line with Directive 1999/31/EC, but the Estonian National Waste Plan for 2023–2028 emphasises increasing safe material recycling and promotion of waste prevention and reuse (see Table 2). By 2028, Estonia aims to increase household waste recycling rate by 29 %.

Table 2. Quantitative Indicators for Evaluation of Effectiveness of Waste Prevention Program in Estonia

No.	Quantitative indicators	Measurement	2020	2028
1	Waste generation per person	kg per capita	4 151	4 000
2	Rate of circulating material	% of total volume	17	25
3	Share of reusable packaging from packaging placed in market	% of total volume	0	10
4	Household waste recycling	% of total volume	29	58
5	Packaging waste recycling	% of total volume	66	70
6	Recycling of construction and demolition waste	% of total volume	32	40
7	Recycling of hazardous waste	% of total volume	48	55
8	Electrical and electronic waste collection rate	% of total volume	62	65
9	Battery and battery waste collection rate	% of total volume	39	63

Source: [9]

Estonia has an obligation to recycle at least 55 % of household waste (recycling means waste is used as material, incineration does not qualify for recycling). The goal must be achieved by 2025. Currently, approximately 30 % of household waste is recycled [10].

Current research reviews the types of waste processed in waste treatment facility serving Riga and its vicinity, Latvia, and several waste treating facilities serving Tartu, Estonia, and establishes a methodology for waste sampling and testing that can help identify types and amounts of waste that can be recycled or processed in addition to already established recycling processes.

2. AN OVERVIEW OF WASTE MANAGEMENT PROCESSES

2.1. Getlini, Latvia

Getlini is a company formed jointly by the municipalities of Riga and Ropazi municipality, which manages the largest solid household waste landfill in the Baltic States. The main objective of the company is to ensure modern, safe and efficient management and disposal of solid household waste as well as production of electricity.

The goal is to ensure continuous improvement of the quality of the services provided and reduction of the environmental impact [11].

The landfill is one of the most modern in Europe, currently developed as a secure waste recycling centre. With the total area of 89.8369 ha, Getlini is formed by the old, reclaimed waste dump site, waste disposal cells, bioreactor, waste recycling infrastructure, as well as infrastructure supporting waste management – facilities, administration buildings, etc. It accepts waste from natural and legal persons, and currently has 1360 contracts in force with legal entities for the acceptance and disposal of household, industrial and construction waste. Waste from natural person is accepted without contract with immediate settlement after delivering the waste to the landfill.

According to information shared by Getlini, total amount of waste received in 2021–2023 is gradually decreasing, i.e., by 24 % comparing 2023 to 2021. The main change is acknowledged in construction waste (-56 % comparing 2023 to 2021). Getlini reviewed tariff for reception of construction waste in 2022 that led to an increase of fees. As a result, the amount of received construction waste dropped due to availability of lower tariffs in the market.

The average composition of total waste is illustrated in Fig. 1. A major part of waste received by Getlini is formed by unsorted household waste (on average 5 9% of total waste amount). The second position takes construction waste (17 %) and waste from the waste management industry (15 %).

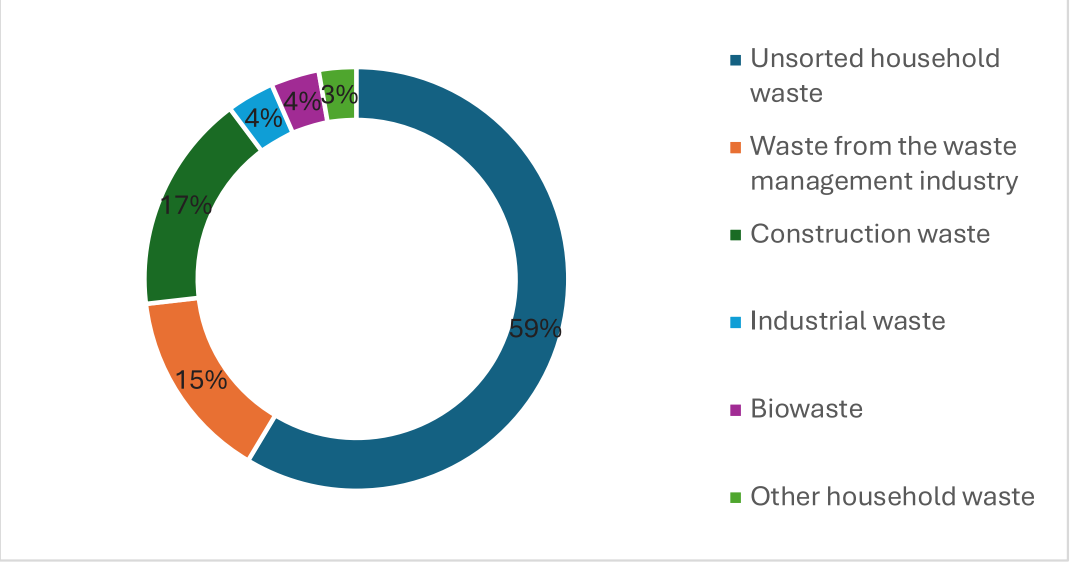

Fig. 1. Average composition of waste received by Getlini in 2021–2023.

Source: [12]

According to information on total produced waste in Latvia in 2021 (see Table 3), Getlini managed 22 % of total produced waste in Latvia. However, Getlini received more than half (55 %) of unsorted household waste and 73 % of biowaste generated in Latvia in 2021.

Table 3. Waste Received by Getlini of Total Produced in Latvia in 2021, t

Waste category	Received by Getlini [17]	Total produced in Latvia [21]	Received by Getlini of total produced in Latvia
Unsorted household waste	268 844	493 046	55 %
Waste from the waste management industry	59 542	443 040	13 %
Construction waste	112 224	394 573	28 %
Industrial waste	21 416	517 473	4 %
Biowaste	27 740	37 803	73 %
Other household waste	23 994	483 313	5 %
Total	513 761	2 369 248	22 %

Source: [13]

Getlini manages four main waste streams: household waste, BDW, industrial waste and construction and demolition waste, although it does not have its own waste sorting station. Waste sorting is ensured by the sorting station located in the landfill site, which was built in 2015 and is managed by "Vides resursu centrs" Ltd. that was selected within a public procurement procedure as a service provider. Getlini does not accept any kind of hazardous waste.

2.1.1. Unsorted Household Waste Sorting Plant and BDW Recycling Complex

In the landfill of Getlini, an unsorted household waste sorting plant was opened in 2015. It is currently managed by Vides resursu centrs Ltd. In the plant, BDW, PET bottles, tin cans, waste containing ferrous and non-ferrous metals, light plastic, textiles, and paper (to produce fuel derived from waste) are mechanically separated and directed to recycling (secondary raw materials). The capacity of the unsorted household waste sorting plant is 300,000 t/year.

The nominal hourly capacity of the sorting plant is 80 tons, which means that a maximum of 960 tons of waste can be sorted per day, on average around 822 tons of waste. The road transport with loads of waste is registered and weighed in Getlini pass house. The quantity of waste accepted is determined by weight – on arrival the total weight of the waste is weighed with the load and on departure the weight of the empty transport is weighed.

Vides resursu centrs Ltd. in its selected technological equipment can separate the following types of waste (by volume):

1. BDW or separated biomass (biomix): 230,000 t/year. This waste is delivered to the landfill site (105,000 t/year for disposal and 125,000 t/year at the BDW recycling facility);
2. non-recyclable or inert waste (residuals) – 40,000 t/year. The waste is transferred to Getlini for landfilling;
3. secondary raw materials suitable for further recycling (~10 % of incoming waste flow) [14].

In BDW recycling complex treats the following waste streams: BDW from gardens and parks, BDW from households, restaurants, catering establishments, retail premises and other similar food cooking merchants where BDW is generated, BDW from mechanical waste processing suitable for composting or anaerobic digestion and plant tissue waste from Getlini greenhouses.

The BDW treatment process is divided into two phases: anaerobic and aerobic fermentation, with the aim to process the biodegradable part of the waste in controlled conditions and generate biogas, which is collected and used for energy production.

Approximately 450 t of BDW are placed in the tunnels and are sealed from the surrounding environment with hermetic doors, ensuring an anaerobic environment. In this stage, BDW is sprayed with an infiltrate solution (percolate), which contains a large amount of organic and inorganic substances that catalyse waste decomposition in the hydrolysis process. The percolate is circulated between the tunnels and methanogenic reactors. A percolate collection/aeration system is installed in the tunnel floors from which all the liquid is diverted to the pump station to be pumped into buffer tanks. After the buffer tank, the percolate is filtered and fed into one of the two 4,200 m^3 methane reactors, where bacteria convert lighter hydrocarbons into methane. Hydrolysis lasts for four weeks; the time is constant and entered in the automation system. Generated biogas is used as fuel to produce heat and electricity at the Getlini power plant. The produced heat and electricity are used in Getlini technological processes, thus promoting the rational and circular use of resources [15].

After hydrolysis, fresh air supply begins for the whole material in one tunnel for a 4-week aeration process, which ensures complete biological processing to stabilise it. Fresh air is delivered through the percolate collection/aeration system installed in the tunnel floor and is pumped from the tunnel through a ventilation pipe installed in the top part of the tunnel. This is achieved with air pumps that create low vacuum in the tunnel. The air pumped from the tunnels is passed through biofilters to reduce emissions and odours that leak into the surrounding environment. During the aeration process, the temperature in the tunnels, according to a natural biological process, is in the range of 45–65 ^{0}C. Consequently, the biomass is made stable in this way. At the end of the composting process, the moisture in the biomass is reduced by 50 %, and the volume decreases by 20 %–30 %.

During the entire processing process, system operators monitor and control technical parameters – tunnel temperature, methane quantity and concentration, percolate flows, etc., using a monitoring, control and data acquisition management system [16].

After the composting process, the stabilised material in the closed tunnel is unloaded with mobile equipment and loaded into a sorting (screening) line hopper. The first separation stage is a drum sieve (drum sieve No 1) with two fractions 0–75 mm and 75–200 mm. The finer fraction is screened by a drum sieve No 2, resulting in 0–30 mm (technical compost) and 30–75 mm fractions. The initial 75–200 mm fraction is sent to a wind sieve, where the finer fraction falls out as potential RDF, while the heavier fraction, along with the 30–75 fraction obtained from drum sieve No 2, is further screened with a star sieve, from which 0–60 (mulch) and 60–200 (landfilled) mm fractions are obtained.

Mulch is used daily as a covering material in the quantity specified in the category A pollution permit while the rest is landfilled. The production capacity is 40,000 t/year. The potential refuse-derived fuel (RDF) material is collected in the screening area and, without storage, is landfilled in the disposal cell. The production capacity is 12,500 t/year. The fraction to be landfilled is collected in the screening area and is buried in the disposal cell without storage [14].

2.1.2. Bioreactor

In the first quarter of 2016, the operation of a bioreactor started in the territory of landfill where BDW is placed with the aim of obtaining biogas. When waste is placed in a bioreactor, leachate recirculation and gas collection systems are also installed in layers, and biogas is obtained. After filling the bioreactor with BDW, it is covered with a temporary reclamation layer. The operation time of the bioreactor is 15 years. At the end of the operation period, the material is sieved, and the following fractions are obtained: technical compost, part to be landfilled (inert materials, potentially they would be admixtures of biological waste that the factory could not separate – of glass or rock origin, small metal, textile, etc.) and energy resource.

Within a year, according to category A pollution permit, it was allowed to place: 230,000 tons of BDW obtained from Vides resursu centrs Ltd., up to 50,000 tons of BDW received from waste management companies, residents, and other merchants, up to 45,000 tons of BDW from construction and demolition and bulky waste sorting line and up to 1000 tons of green mass (leaves and stems) generated in greenhouses at the landfill site [14].

Figure 2 shows the amount of biogas produced by Getlini in 2022 and its methane content. On average, Getlini produces 190,000 m^3 of biogas per month with methane content exceeding 50 %. The volume of produced biogas is gradually decreasing (-26 % comparing December 2023 to January 2023).

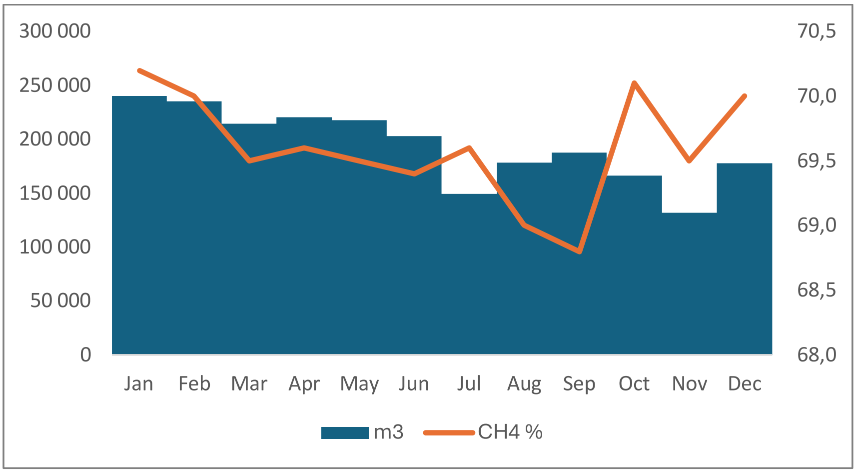

Fig. 2. Biogas produced by Getlini in 2023 and its methane content.

Source: [12]

Landfill gas, mainly consisting of methane (50–55% by volume) and carbon dioxide (45–50% by volume), is formed during the waste decomposition process [17]. Releasing methane into the atmosphere is environmentally unfavourable because it creates a greenhouse effect, contributing to global climate change. To reduce the release of greenhouse gases (GHG), Getlini collects and burns the gas from the waste in the cogeneration plant, producing thermal energy and electricity. Electricity is sold on the free market while thermal energy is used in the greenhouses of Getlini [14].

However, in future the possibility of biomethane production and injection into the gas distribution network can be reviewed [18]–[22].

2.1.3. Landfill Cell

Waste landfilling cells are located adjacent to the old, remediated waste dump site, and they are equipped with an appropriate base – peat was excavated throughout the area, the base was filled with gravel or sand, covered with a geotextile and a layer of clay as well as a water-impermeable film lining protected by a geomembrane. Above this isolating layer a drainage system for infiltrate collection was installed.

In the landfill, a 50-ton compactor operates, which compacts the delivered waste. When placing waste and after its compaction, a regular covering is applied using a hardening substance. The regular covering is performed by the service provider who delivers the material intended for the covering to the site. This covering also uses mulch from BDW processing.

When placing waste in disposal cells, gas collection pipes (perforated, flexible pipes) are installed in it every approximately 6 meters upon reaching the thickness of the waste layer.

The following waste types are placed in the cell:

1. waste separated in the unsorted household waste sorting plant and not suitable for further recycling (sorting residuals);
2. mechanically sorted biowaste that cannot be recycled at BDW recycling complex due to its capacity;
3. unsorted household waste in emergency situations as well as during periods when maintenance work is carried out in the unsorted household waste sorting plant;
4. waste brought to the landfill site and not suitable for further treatment/recycling (industrial and household waste that meets the permitted types of waste for disposal at the household waste landfill according to the Cabinet Regulations No 1032 "Regulations Regarding Landfill Sites" [23]);
5. waste generated during waste recycling processes at Getlini, for example, waste separated at the construction and demolition sorting line, waste generated during sieving process at BDW recycling complex and not suitable for further recycling [14].

2.1.4. Sorting and Recycling of Construction Waste without Significant Impurities

Separate waste streams are accepted for crushing (recycling) construction waste which already have a low level of impurities in their composition. These are mainly demolition materials (concrete, asphalt and bricks). This material is crushed to form multiple fractions, while separated metal is stacked separately for later sale. Waste with a low mixture of plastics, rubber, and other types of waste ends up on the crushing line.

Wood-origin waste is collected and stacked in a separate pile which is shredded twice a year and currently sold to other waste management companies [14].

2.2. Tartu Municipality, Estonia

According to the Environmental Register, there are a total of 45 working waste treatment facilities in the city of Tartu. The most important waste treatment sites are the Aardlapalu transfer station, the biogas plant of the Tartu wastewater treatment plant, the

Ilmatsalu biogas and cogeneration plant, the South Estonian Hazardous Waste Management Centre, and the health care waste management site of Tartu University Clinic [10].

2.2.1. Collection and Transportation of Waste

One of the most important tasks of the municipality is to organise the collection and transport of household waste. The city is holding a public tender to find a waste hauler. Only the waste handler who has won the competition organised by the city may transport household waste in the area. Residents sign a contract with this company and pay the company directly. The municipality does not have garbage trucks, all work is done by the private sector based on public procurement.

The organised waste transport includes the following types of waste:

1. mixed household waste, which is taken to the Aardlapalu transfer station;
2. wastepaper, which is handed over to a company with a corresponding environmental permit;
3. biowaste, which is taken to Aardalpalu transfer station and composted there.

Residents and companies must hand over mixed household waste, biowaste and wastepaper to the company that won the organised waste transport tender. Four areas of Tartu municipality currently have one waste carrier – Eesti Keskonnateenused AS, who won tenders in all consequent areas.

In addition to organised waste transportation, the city of Tartu also organises waste collection by their type. At least the following types of waste must be collected separately in Tartu: paper and cardboard, packages, hazardous waste, biowaste, hazardous waste (refrigerators, TVs, computers, tires, etc.), bulky waste (furniture), metals, and textiles.

There are four ways to collect waste by type:

1. in a separate container next to the house for the collection of the corresponding type of waste (wastepaper and biowaste are collected this way). A separate container for wastepaper must be in apartment buildings with at least 5 apartments. The city also has public containers for private homes. There must be a separate container for biowaste in all properties;
2. in collection points on the territory of the city for the collection of different types of waste (packages, textiles, hazardous waste and wastepaper are collected in this way). The city has a public collection network for collecting packaging and textiles. About 100 containers have been installed in the city for packaging, 15 containers for textiles;
3. waste collected separately can be taken to a waste station;
4. waste is accepted by waste handlers (e.g., metal, construction waste).

Packaging manufacturers organise packaging collection. Producers are obliged to place collection points in the city in such a way that there is one collection point within a radius of approximately 500 meters from each household.

Collection points have been set up in the city for the collection of hazardous waste, expired/unused medicine can be handed over at pharmacies. Basically, hazardous waste is taken to waste plants.

Residents can hand over all types of waste at waste stations. There are two waste stations in Tartu that accept:

1. hazardous waste (batteries, paint and medicine waste, daylight lamps, etc.);

2. bulky waste (including old furniture);
3. electronic waste (refrigerators, TVs, etc.);
4. recyclable waste (wastepaper and metal, plastic and glass containers);
5. packaging waste;
6. wood, construction waste and similar.

Recycling centres operate in Tartu, where residents can discard furniture, dishes, books, clothes, toys etc. Items are organised in centres and sold for a small amount of money. Recycling centres are managed by non-profit organisations, and the city supports the activities financially.

According to Tartu waste management regulations, the following must be collected separately on the construction site: hazardous waste by type (it is not allowed to pour liquid hazardous waste such as paints, varnishes, solvents, glues, etc. into the hazardous construction waste collection container), wood, packaging, metals, permanent waste (stones, plaster, concrete, plaster, etc.), plastics and other mixed waste [24].

2.2.2. Aardlapalu Transfer Station

The mixed household waste collected from the city of Tartu is taken to the Aardlapalu transfer station. From there mixed household waste is directed to the following treatment sites: Iru mass incineration plant, Tallinn Waste Recycling Centre, the mechanical-biological processing plant located on Suur-Sõjamägi in Tallinn, the Uikala landfill (to produce waste fuel) and the Paikre, Torma and Väätsa landfills. To which waste treatment facility, the waste is currently sent depends on the operator of the Aardlapalu transfer station. However, based on the agreement between the city of Tartu and the operator, the principles of the waste hierarchy must be observed when choosing the final disposal site, and the largest possible share of mixed household waste must be directed to recycling (waste incineration, waste fuel production). Transferring waste to a landfill is permitted only as an exception. As part of the waste transport procurement, the city of Tartu has so far considered mechanical-biological processing as equivalent to mass incineration of mixed household waste.

At the end of 2013, a composting station was built in Aardlapalu where it is possible to compost food waste in an environmentally safe way, a waste sorting building and a reloading station with a garbage compactor [10].

2.2.3. Sorting Station

There is a sorting station operated by Ragn Sells AS in the city of Tartu where waste is accepted only from business customers according to the price list. Ragn Sells AS accepts construction and demolition waste, household waste, bulky waste, wood, excavated surface, glass, old tires, wastepaper, concrete, brick, tile or ceramic mixture. The sorting station also has the function of a transhipment centre for mixed household waste [10].

2.2.4. Biogas Plant

The biogas generated at the plant (up to 3,000 m^3 per day, methane content 65 %) is used as fuel in the on-site combined heat and power plant with an installed capacity of 300 kW. In a biogas plant, sewage sludge can be handled anaerobically together with other organic waste, which can be up to 10 % of the total volume as dry matter [10].

2.2.5. South Estonian Hazardous Waste Management Centre

In the administrative territory of the city of Tartu, the Southern Estonia hazardous waste management centre operates, which is managed by the hazardous waste management company Epler&Lorenz that operates on the same property. The management of the hazardous waste collection system is the responsibility of the state (i.e., the city of Tartu has no obligations in managing the centre). In addition to the collection of hazardous waste, waste is burned in a waste incineration plant, and polluted soil is cleaned using bag composting technology [26].

2.2.6. Statistic Data on Waste and Biogas Amount

Statistical information on waste collected in Tartu in 2019 and 2021 is shown in Table 4 below.

Table 4. Waste Collected in Tartu in 2019 and 2021, t

Waste category	**2019**	**2021**
Construction and demolition debris, including soil removed from contaminated land areas	214 515	215 594
Waste from waste management companies, non-company wastewater treatment plants, and drinking and industrial water management	83 595	130 805
Waste generated in agriculture, horticulture, aquaculture, forestry, hunting and fishing and food preparation and processing	64 625	58 734
Municipal waste (household waste and similar commercial, industrial and official waste), including separately collected waste	42 946	41 459
Packaging waste, absorbents not listed elsewhere, cleaning rags, filter materials and protective clothing	17 865	16 666
List of waste not specified elsewhere	8 371	7 956
Waste from mechanical shaping of metals and plastics and physical and mechanical surface treatment	4 175	3 887
Waste generated in organic chemical processes	1 249	1 550
Oil and liquid fuel waste (except edible oils)	594	768
Waste generated during human or animal health care or related research (except kitchen and canteen waste that is not directly related to health care)	513	601
Waste generated in thermal processes	159	550
Waste from the manufacture, mixing, distribution and use of surface coatings (paints, varnishes and vitreous enamels), adhesives, sealants and printing inks	517	539
Photographic waste	23	24
Waste generated during the surface treatment and coating of metals and other materials and hydrometallurgical processes of non-ferrous metals	8	20
Wastes of organic solvents, refrigerants and propellants	14	17
Waste from wood processing, tiles and furniture and pulp, paper and cardboard production	47	12
Total	439 216	479 182

Source: [25]

Total value of collected waste increased by 9 % in 2022 compared to 2019. The main part of waste collected by Tartu city is formed by construction waste (47 % of total average waste amount collected in 2019 and 2022). The second position takes waste from waste management companies, non-company wastewater treatment plants, and drinking and industrial water management (23 %; see Fig. 3 below).

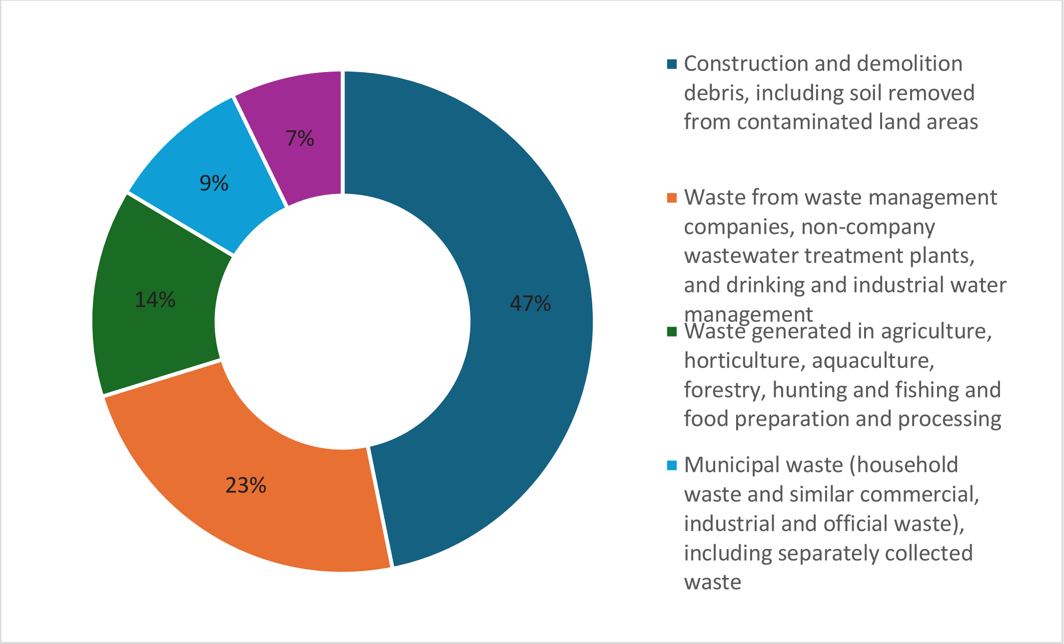

Fig. 3. Average composition of waste collected by Tarty city in 2019 and 2021.

Source: [25]

According to Table 5, at least 61 % of waste generated and imported to Tartu city is recycled. There is a high recycling level of construction and agricultural waste – 75 % and 100 %.

Table 5. Waste Recycled in Tartu in 2019, t

Waste category	**Collected**	**Imported**	**Total managed**	**Recycled**	**Recycling rate**
Construction and demolition debris, including soil removed from contaminated land areas	214 515	20 616	235 131	176 524	75 %
Waste from waste management companies, non-company wastewater treatment plants, and drinking and industrial water management	83 595	1 566	85 161	8 810	10 %
Waste generated in agriculture, horticulture, aquaculture, forestry, hunting and fishing and food preparation and processing	64 625	31 284	95 909	95 560	100 %
Municipal waste (household waste and similar commercial, industrial and official waste), including separately collected waste	42 946	2 227	45 173	5 698	13 %
Other waste	33 535	5 646	39 181	20 530	52 %
Total	439 216	61 339	500 555	307 122	61 %

Source: [25]

Figure 4 illustrates the amount of waste incinerated in Tartu in 2020–2023. The volume of incineration will gradually increase since 2020 by reaching 24 757 tons in 2023.

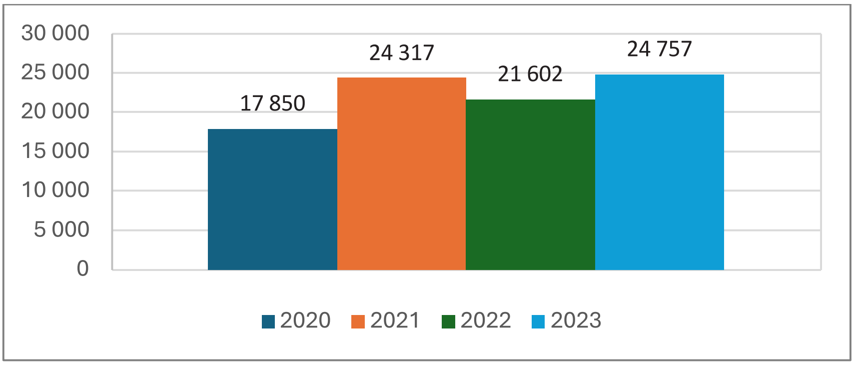

Fig. 4. Mixed household waste incinerated in Tartu in 2020–2023, t.

Source: [25]

Figure 5 illustrates the volume of biogas produced in Tartu in 2021–2023 and its methane content (through the gas collection system of the closed landfill in Aardlapalu).

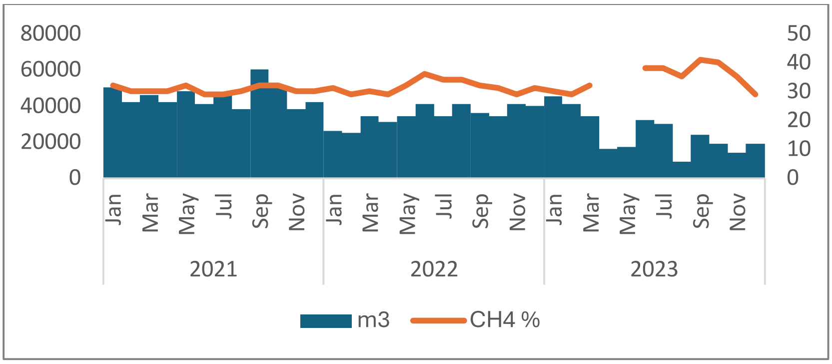

Fig. 5. Statics on biogas produced in Tartu in 2021–2023 and its methane content.

Source: [25]

Volume of produced biogas reduced by 62 % comparing December 2023 to January 2021. The average content of methane equals 32 %.

3. SIMILARITIES AND DIFFERENCES

The common and different features of Getlini and Tartu waste management processes are reflected in Table 6.

Table 6. The Common and Different Features of Getlini and Tartu Waste Management Processes

<table>
<tr><td colspan="2">Similarities</td></tr>
<tr><td colspan="2">Getlini and Tartu city have similar waste processing opportunities – sorting station, biogas plant and landfill.
In 2021, Getlini and Tartu managed comparable volume of waste. Getlini – 513,761 tons; Tartu – 479,182 tons.</td></tr>
<tr><td colspan="2">Differences</td></tr>
<tr><td>Getlini, Latvia</td><td>Tartu Municipality, Estonia</td></tr>
<tr><td>Getlini is a company formed jointly by the municipalities of Riga and Ropazi. Getlini does not operate as a recycling station, the main function of Getlini is management of waste, which is directed to landfill cell – the last stage of waste management process.
Total amount of waste received in 2021–2023 by Getlini is gradually decreasing, i.e., by 24 % comparing 2023 to 2021. The main change is acknowledged in construction waste (-56 % comparing 2023 to 2021) due to an increase in tariffs.
59 % of waste received by Getlini is formed by unsorted household waste.
Getlini managed 22 % of total produced waste in Latvia in 2021. However, Getlini received more than half (55 %) of unsorted household waste and 73 % of biowaste generated in Latvia in 2021.
In 2023, Getlini landfilled 53 % of the received waste. The value of landfilled waste significantly increased in 2022 due to reaching of maximum capacity of bioreactor in May 2022 where notable amount of household waste suitable for composting or anaerobic digestion was placed.
Industrial waste received by Getlini has the highest landfilled proportion that reached 100 % of total received industrial waste in 2023,</td><td>Tartu is a municipality, which organises the collection and transport of household waste; it does not take the function directly. Waste management processes are taken by merchants through public tender. Tartu municipality takes the role of control.
Total value of collected waste in Tartu increased by 9 % in 2022 compared to 2019. Waste mainly is formed by construction waste (47 %).
Tartu uses an opportunity to incinerate mixed household waste.
Tartu has a high recycling level of construction and agricultural waste – 75 % and 100 %.</td></tr>
</table>

Volume of waste, its composition and management processes do not correlate between Getlini and Tartu. It triggers a requirement for development of aligned waste sampling and testing procedures.

4. WASTE SAMPLING AND ANALYSIS

4.1. Getlini, Latvia

According to Cabinet Regulation No 1032 and Category A Polluting Activity Permit, Getlini is testing the following types of waste: residuals from sorting of unsorted household waste (household waste after sorting that is landfilled) and mechanically separated BDW, which is transferred to BDW recycling complex (from unsorted household waste).

Getlini conducts composition measurements of sorting residuals once a quarter by inviting an accredited laboratory, which determines the specific weight of each fraction in the residuals. Determining the composition of household waste for disposal, the waste is sorted into the following fractions:

1. paper and waste containing paper (e.g., packaging, paperboard, tetra packages, mixed wastepaper and paperboard);
2. plastic and plastic-containing waste (for example, packaging, film, mixed plastic waste);
3. glass and glass-containing waste;
4. wastes containing metals;
5. BDW and biowaste;
6. construction and demolition waste;
7. waste electrical and electronic equipment;
8. waste batteries and accumulators;
9. textile waste;
10. large waste (at least one external dimension exceeding 50 cm);
11. fine fraction (dimensions of household waste less than 10 mm);
12. other household waste that does not fit into the fractions mentioned in this point.

Sample preparation is carried out by laboratory specialists in accordance with the methodology established by Cabinet Regulation No 1032, namely, samples of household waste are taken from all waste loads within a specified period of time (the incoming loads are directed to the unsorted household waste sorting plant, the sample is taken from a waste pile that contains post-sorting waste and is prepared for transportation to the disposal site).

Household waste from which a sample will be taken shall be discharged into a conical stack and divided vertically into four equal parts in two imaginary lines. Two opposite quarters of the conical pile are mixed into one sample in a conical pile, which is then again divided vertically into four equal parts in two imaginary lines, but the remaining two quarters are not included in further operations. These actions are repeated until the household waste sample size is reached.

Laboratory specialists manually sort the household waste sample according to the household waste fractions. After sorting, the waste from each household waste fraction is weighed and their weight is recorded. The sample size varies on average from 100 to 250 kg.

Getlini, in addition to the mandatory testing conducted once a quarter, also analyses the composition of unsorted household waste (received household waste before sorting) using the same approach and determining the same fractions as for the residual of sorted household waste [14].

The sampling and testing procedure is prescribed by Cabinet Regulation No 1032.

To verify the efficiency of unsorted household waste sorting process and determine whether the BDW contains a sufficient proportion of biological waste for further processing (the content of impurities may not exceed 30 %), Getlini shall, by inviting an accredited laboratory, perform testing of BDW sorted from household waste once a week, determining the following parameters:

1. percentage by mass of moisture (standard LVS CEN/TS 15414-1:2020);
2. non-biomass percentage (standard LVS EN ISO21644:2021);
3. percentage by mass of inert waste (standard LVS EN ISO21644:2021);
4. mass percentage of biomass content in a dry sample (standard LVS EN ISO 21644:2021);
5. percentage by mass of the number of impurities in the wet sample – calculation.

Moreover, in addition to waste composition, Getlini started testing of chemical parameters of:

1. residuals of sorted household waste, which is currently being landfilled;
2. mixed construction waste, which is currently being landfilled;
3. waste resulting from sieving of the fermented mass from BDW recycling complex, which is currently being landfilled;
4. wood-containing waste accepted at the construction and demolition waste and bulky waste sorting line, primarily consisting of wood from construction waste, furniture, packaging, garden, and park waste, etc., and which, after accumulating a certain volume, is handed over to other waste management operators (woodchips).

Table 7 reflects parameters that are determined within chemical analysis.

Table 7. Chemical Parameters that are Determined in Waste by Testing Laboratory Invited by Getlini

Parameter	**Measure**
Moisture content	%
Ash content	%
Gross calorific value at constant volume	MJ/kg, kcal/kg MWh/t
Net calorific value at constant pressure	MJ/kg, kcal/kg MWh/t
Sulphur	%
Nitrogen	%
Total carbon content	%
Hydrogen	%
Fines <10mm	%
Biomass content (selective dissolution method)	%
Biomass content (selective dissolution method) express as percentage carbon of total carbon	%
Shrinkage starting temperature	°C
Deformation temperature	°C
Hemisphere temperature	°C
Flow temperature	°C
Chemical elements: Na, Mg, Al, Si, P, K, Ca, Ti, Cr, Mn, Fe, Ni, Cu, Zn, As, Cd, Hg, Pb,	mg/kg
Chemical elements: S, Cl	%

Source: [26]

4.2. Tartu Municipality, Estonia

In the city of Tartu, there is no regular testing in place, and there is no regulated procedure for such testing. The Ministry of Environment orders sorting studies at the interval of 2–3 years. These studies gather data from 3–4 municipalities, and the data is generalised for the whole country. Usually, studying does not cover Tartu municipality. Therefore, the data does not represent the situation in Tartu. Tartu has conducted its own surveys described below.

Sorting studies have been carried out in 2011 when the study of biogas raw materials of Tartu city and Tartu County was carried out by the Institute of Sustainable Estonia. In October 2019, Tartu carried out waste sorting survey MAVES Tallinn, and in December 2023 the municipal waste sorting study was carried out by Tartu City Government. Within this framework, the average composition of Tartu's mixed municipal waste was assessed. These were carried out by Tartu city to assess how much recyclable material went to waste as mixed household waste.

Sampling of the analysed waste was carried out based on the international and methodological framework used in the previous household waste studies conducted in Estonia (including Tartu):

1. Standard EVS-EN14899:2006 – Characterization of waste. Sampling of waste materials. A framework for preparing and implementing a sampling plan;
2. Methodological guidance material NT ENVIR 001: Solid Waste, Municipal: Sampling and Characterization prepared by Nordtest;
3. American standard ASTM D5231-92(2016): Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste [10].

The waste samples were taken from the waste loads previously agreed with the waste handlers, which were collected from the respective study areas. A total of five samples were taken from each load. Data on the analysed waste loads, the number of containers making up the waste load for 2023 and sample weights are given in Table 8.

Table 8. Data on the Analysed Waste Load, the Number of Containers Making Up the Waste Load and the Average Weight of the Samples Taken for Analysis, 2023

Data of the study period		**Annelinn**	**Former Tähtvere municipality**	**Variku**	**City Centre**	**Mean**
Study period I	Number of containers	51	91	322	114	145
	Load weight, t	6,8	5,0	8,6	3,2	5,9
	Average sample weight, kg	93.2	93.0	93.5	100.7	95.08
Study period II	Number of containers	51	90	171	172	121
	Load weight, t	7,2	2,4	4,3	7,4	5,3
	Average sample weight, kg	99.6	95.8	95.8	96.2	96.84
Study period III	Number of containers	51	90	171	172	121
	Load weight, t	7,2	2,3	4,3	7,4	5,3
	Average sample weight, kg	97.5	109.9	91.5	98.1	99.25
Study period IV	Number of containers	61	220	192	124	149
	Load weight, t	6,1	6,2	5,0	5,9	5,8
	Average sample weight, kg	94.9	95.7	96.8	98.2	96.4

Source: [25]

The waste from Variku, Annelinna, Kesklinna districts and former Tähtvere municipality was analysed at the Aardlapalu transfer station (Kambja parish, Uhti village, Aardlapalu). The waste load was mixed and spread out in an even layer. The scattered waste was divided into four groups, and after grouping the waste and reducing the amount of material, a waste sample weighing about 100 kg was taken into a 600–770 litre container.

The waste sample was manually sorted on a sorting table (including screening out particles smaller than 20 mm) according to the agreed waste types, and then the separated waste types were weighed.

Based on the aggregated results of the sorting study, it can be stated that the largest proportion of the analysed mixed household waste is biowaste (29.9 %) and other combustible material (diapers and sanitary napkins, rubber, cotton wool, contents of vacuum cleaner bags, roll material for floor covering), followed by paper and cardboard (16.45 %) and plastic (15.45 %).

In addition to the mixed household waste sorting survey, Tartu city also carried out observations of mixed household waste at the client's premises – the so-called garbage bingo project.

At the customer's place, the mixed household waste container was emptied into the garbage truck, and it was assessed by external observation whether there was inappropriate waste in the container. On the spot, the data was entered into the information system and the contents of the container poured into the car were photographed. In case of non-compliant waste, the customer was contacted. In 2023, it was organised three times, and approximately 1000 containers were analysed [10].

A comparison of the aggregate results of this sorting study with the results of similar studies previously conducted in Tartu (2011 and 2019 studies) is provided in Table 9.

Table 9. A Comparison of the Aggregate Results of Sorting Studies Conducted in Tartu in 2011, 2019 and 2023

Waste type (material based)	2011 average	2019 average	2023 average
Glass	3.2	4.4	6
Plastic	15.2	16.6	15.4
Paper and cardboard	17.1	20.2	16.5
Metal	2.2	2.3	1.5
Wood	0.5	0.9	0.6
Bio waste including:	38.4	31.8	29.1
garden waste	9.4	7.5	4.7
kitchen waste	27.6	24.3	23.4
other biowaste	1.4	0.1	1
Textiles and clothes	0.9	5.9	3.6
Hazardous waste	0.3	0.6	0.1
Electronic waste	0.4	0.6	0.9
Other non-combustible (inert) material	6.1	5.4	3.6
Other combustible material	15.7	11.3	22.7
Total	100	100	100

Source: [10]

When comparing the results of this study with previous studies, the biggest change in the direction of increase has occurred in the content of other combustible materials. At the same time, it must be taken into account that the share of this type of waste is relatively large, and as the share of other types of waste (especially biowaste) changes, it increases. Therefore, it is more important to pay attention to the decrease in the proportion of biowaste compared to the previous sorting survey. The decrease in the proportion of biowaste compared to the 2011 sorting survey is particularly noticeable. The promotion of separate collection of biowaste in recent years in Tartu has contributed to the decrease in the proportion of biowaste.

5. CONCLUSIONS

- The regulatory framework for waste management in Latvia and Estonia is comprehensive, featuring multiple regulatory enactments that are supplemented by the National Waste Plan. Latvia and Estonia have similar responsibilities, permitting system and reporting. Supervision of waste management in Latvia and Estonia are similarly entrusted, with main supervisory institutions – state bodies.
- In Latvia, waste management reporting is a collaborative effort between the public and private sectors, encompassing various stakeholders such as specialised waste managers and local governments. Meanwhile, in Estonia, reporting is apparently only the duty of certain representatives of the private sector. In Latvia, the need to submit financial security in order to receive a waste management permit is determined for more permits for certain activities compared to Estonia. Persons wishing to obtain a waste management permit for certain activities must pay a state duty. Meanwhile, the Estonian regulation does not provide information about the obligation to pay the state duty.
- Getlini and Tartu city have similar waste processing opportunities – sorting station, biogas plant and landfill. In 2021, both have processed comparable amount of waste: Getlini – 513,761 tons; Tartu – 479,182 tons. The main difference between Getlini and Tartu is that Getlini is a company formed jointly by the municipalities of Riga and Ropazi, the main function of which is management of waste that is directed to landfill cell, and Tartu is municipality that organises collection and transport of household waste.
- The waste profile of Tartu is predominantly characterised by construction waste (47 %). 59 % of waste received by Getlini is formed by unsorted household waste. Tartu uses mixed household waste for incineration and has a very high recycling level of construction and agricultural waste, 75 % and 100 %, respectively. In 2023, Getlini landfilled 53 % of the received waste. The value of landfilled waste significantly increased in 2022 due to reaching maximum capacity of bioreactor in May 2022 where notable amount of household waste suitable for composting or anaerobic digestion was placed. Production waste received by Getlini has the highest landfilled proportion that reached 100 % of total received production waste in 2023.
- Volume of waste, its composition and management processes do not correlate between Getlini and Tartu. It triggers a requirement for development of aligned waste sampling and testing procedures.
- Based on requirements of legislative acts, Getlini is testing residuals of sorted household waste (household waste after sorting that is landfilled) and mechanically separated BDW, which is transferred to BDW recycling complex (sorted household waste). The test includes analysis of morphology of waste aimed at determining whether the waste meets the requirements for landfill or recyclable waste. In the city of Tartu, there is no regular testing in place, and there is no regulated procedure for such testing.
- The procedures for waste sampling and analysis of residuals of household waste

after sorting at Getlini are governed by stringent legislative acts, ensuring consistency in the sampling process, the quantity and fractions of samples collected.

- Within the scope of this study, Getlini made the following tests of waste:
  - chemical test of residuals of sorted household waste, which is currently being landfilled. According to mandatory morphological test, 68 % of residuals are formed by paper and plastic. Chemical parameters have similar measures at all testing dates, except for results of some chemical elements that have significant fluctuations;
  - morphological and chemical test of mixed construction waste, which is currently being landfilled. The main part of mixed construction waste is formed by fines in fractions below 10 mm. Chemical parameters of tested mixed construction waste have significant fluctuations at testing dates;
  - chemical test of waste resulting from sieving of the fermented mass of the BDW from BDW recycling complex, which is currently being landfilled. Chemical parameters at testing dates have low volatility around average value, except for chemical elements that fluctuate a lot;
  - chemical test of wood-containing waste (woodchips). Since woodchips are placed out of doors, these are affected by weather conditions. As a result, moisture content has significant fluctuation at testing dates that impacts calorific values. Moreover, chemical elements have high volatility around average values.
- By involving an accredited laboratory for precise waste sampling, Getlini adheres to internationally recognised standards and national regulations, ensuring robust and accurate manual separation of waste into 12 distinct fractions. Sample size is considered appropriate to get overview of the waste, it is also in line with the requirements of Cabinet Regulations No 1032, international practice and standards:
  - for residual of sorted household waste from 100 to 250 kg;
  - for mixed construction waste from 300 to 400 kg.

ACKNOWLEDGEMENT

The research has been funded by I3-2022-CAP2b, project “Circular Economy for Riga and Tartu Waste Management Facilities” (CERITA), Grant Agreement from 101133105.

REFERENCES

1. Eurostat. (2023). *Waste Statistics.* Available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_statistics
2. Ozbay, G., Jones, M., Gadde, M., Isah, S., & Attarwala, T. (2021). Design and Operation of Effective Landfills with Minimal Effects on the Environment and Human Health. *Journal of Environmental and Public Health*, 1–13. 10.1155/2021/6921607.
3. Hoang, M., Pham P., Song, T., Fujiwara, T.,

& Pham Van, D. (2020). Waste-to-Landfill Reduction: Assessment of Cost-Effective Solutions using an Optimization Model. *Chemical Engineering Transactions*, *78*. 10.3303/CET2078086.

4. Parveen, N., Azam, R., & Dingh, D. (2020). *Innovations in Recycling for Sustainable Management of Solid Wastes*. IGI Global. 10.4018/978-1-7998-0031-6.ch010.
5. Sauhats, A., Broka, Z., & Baltputnis, K. (2021). Energy Transition of the Baltic States: Problems and Solutions. *Latvian Journal of Physics and Technical Sciences*, *58* (3), 3–14. doi: 10.2478/lpts-2021-0013.
6. EC. (1999). *Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste*. Available at http://data.europa.eu/eli/dir/1999/31/oj
7. MK. (2021). *Atkritumu apsaimniekošanas valsts plāns 2021.–2028. gadam*. Available at https://www.varam.gov.lv/lv/media/6191/download?attachment
8. LSM.lv (2023). *Landfills Still Bury too much Waste in Latvia*. Available at https://eng.lsm.lv/article/society/environment/03.04.2023-landfills-still-bury-too-much-waste-in-latvia.a503495/
9. Estonian Ministry of the Environment. (2023). *National Waste Plan 2022–2028*. Available at https://www.envir.ee/j%C3%A4%C3%A4tmekavaksh
10. Tartu Municipality. (n.d.) *Tartu City Provided Description of Waste Management Processes*. Available at https://tartu.ee/en/waste-management
11. Zigurs, A., Balodis, M., Ivanova, P., Locmelis, K., & Sarma, U. (2019). National Energy and Climate Plans: Importance of Synergy. *Latvian Journal of Physics and Technical Sciences*, *56* (6), 3–16. doi: 10.2478/lpts-2019-0031.
12. Getlini.lv (2024). *Getliņi EKO Statistical Data on Received, Used and Landfilled Waste for 2021–2023.* Available at https://www.getlini.lv/publicets-uznemuma-auditetais-gada-parskats-par-2023-gadu/
13. Latvijas Vides, ģeoloģijas un meteoroloģijas centrs. (2022). *Valsts statistiskā pārskata "Nr.3 – Atkritumi. Pārskats par atkritumiem" kopsavilkums par 2021.g.* Available at https://www.google.com/url?sa=i&url=https%3A%2F%2Fvidescentrs.lvgmc.lv%2Ffiles%2FVide%2FAtkritumi_un_radiacijas_objekti%2FNr_3_parskats_par_atkritumiem%2F3Atkritumi_kopsavilkums_2021.pdf&psig=AOvVaw27EAIXwLOsQodau33OxViH&ust=1723181726218000&source=images&cd=vfe&opi=89978449&ved=0CAYQrpoMahcKEwjorZGn1uSHAxUAAAAAHQAAAAAQBA
14. Getlini.lv. (n.d.). *Description of Activities of Geliņi EKO*. Available at https://www.getlini.lv/
15. Kamil, F. H., & Waleed, M.A. (*2021). Circular Economy and Solid waste Management for Sustainable Environment.* Available at https://www.researchgate.net/publication/357555187_Circular_Economy_and_Solid_waste_Management_for_Sustainable_Environment
16. Zemite, L., Kleperis, J., Mezulis, A., Bode, I., Vempere, L., Jasevics, A., & Jansons, L. (2022). Biogas Production Support Systems for the Production and Use of Biomethane. In *2022 IEEE International Conference on Environment and Electrical Engineering and 2022 IEEE Industrial and Commercial Power Systems Europe*, (pp. 1–6). Prague, Czech Republic. doi: 10.1109/EEEIC/ICPSEurope54979.2022.9854739.
17. EPA. (n.d.). *Basic Information about Landfill Gas*. Available at https://www.epa.gov/lmop/basic-information-about-landfill-gas
18. Savickis, J., Zemite, L., Zeltins, N., Bode, I., Jansons, L., Dzelzitis, E., … & Ansone, A. (2020). The Biomethane Injection into the Natural Gas Networks: The EU's Gas Synergy Path. *Latvian Journal of Physics and Technical Sciences*, *57* (4), 34–50. doi: 10.2478/lpts-2020-0020.
19. Zemite, L., Jansons, L., Zeltins, N., Lapuke, S., & Bode, I. (2023). Blending Hydrogen with Natural Gas/Biomethane and Transportation in Existing Gas Networks. *Latvian Journal of Physics and Technical Sciences*, *60* (5), 43–55, doi: 10.2478/lpts-2023-0030.

20. Jansons, L., Bode, I., Koposovs, A., Zeltins, N., & Lapuke, S. (2023). Gas Distribution System of Latvia and its Transitional Challenges. *Latvian Journal of Physics and Technical Sciences*, *60* (6), 85–99. doi: 10.2478/lpts-2023-0038.
21. Selickis, A., Jansons, L., Bode, L., Zemite, L., & Zeltins, N. (2023). Basis of operational planning methodology in diversified gas distribution systems. In *2023 IEEE 64th Annual International Scientific Conference on Power and Electrical Engineering of Riga Technical University, RTUCON 2023 – Proceedings*, (pp. 1–15). 9–11 October 2023, Riga, Latvia. Piscataway: IEEE. doi: 10.1109/RTUCON60080.2023.10412954.
22. Jansons, L., Silina, J., Bode, I., Zemite, L., Zeltins, N., & Palkova, K. (2024). Injection of Renewables Gases into the Existing Gas Distribution Grids and Employment of Reverse Gas Flow Technique. *Latvian Journal of Physics and Technical Sciences*, *61* (2), 66–79. doi: 10.2478/lpts-2024-0013.
23. MC Regulations. (2011). *Regulations Regarding Landfill Sites*. Available at https://likumi.lv/ta/id/242189-atkritumu-poligonu-noteikumi
24. Dianda, P., Taleb, M.A., & Munawar, E. (2018). Production and Characterization Refuse Derived Fuel (RDF) from High Organic and Moisture Contents of Municipal Solid Waste (MSW). *IOP Conference Series Materials Science and Engineering, 334* (1), 012035. doi: 10.1088/1757-899X/334/1/012035
25. Tartu Municipality. (n.d.) *Statistical Data on Waste*. Available at https://tartu.ee/en/sustainable-tartu
26. Virsma SIA. (n.d.). *Testing Reports*. Available at https://www.virsma.lv/