

WASTE MANAGEMENT - STUDY CASES

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Abstract

Waste are a big problem in the economy and not only affecting environment quality. For this reason, it is compulsory to find solutions to reconvert these waste to avoid pollution. This paper presents the management and utilization of waste from the 11 wood industry factories in the city of Reghin, Mureș county, Romania and also a few case studies in agriculture where solutions were found to increase production and maintain environment quality. Wood waste is a category that can be used to obtain energy by burning or composting sawdust that can be used as fuel, sawdust that can be used for wood boilers, for panel panels or for paper pulp, or in animal husbandry as litter for animals. The purpose of the study was the study of waste management within these companies, where we found that a simple production results in several categories of waste such as: glass, plastic, paper, chemicals, oils, glues, paints, combustion ash, slag and the largest amount of wood waste. To increase production and reduce manufacturing costs, we recommend reintroducing this wood waste back into the production cycle, harnessing it in the form of thermal energy.

Key words: wood waste, energy recovery, case studies, Romania, France, Spain

INTRODUCTION

Wastes are a big problems related to environment pollution and human health. An important amount of waste materials could be reintroduced and recycled into the economic circuit by manufacturing processes [12].

By recycling industrial waste we could obtain a cleaner production and prevent environment pollution. In this way sustainable development could be achieved [17].

The EC Green Plan set up in 2020 has initiated a new approach of waste management for ensuring a sustainable development, more precisely, passing from linear to circular economy which means waste collection and recycling and its reuse as input raw materials in the production process [5].

There are many types of wastes from industry, agriculture, forestry, tourism, constructions, households etc.

In Romania, wood waste represents a significant part of the total waste, because it results from numerous sources such as: industry, the development of green spaces, people's households, forest exploitation, construction and demolition [8]. As per the legislation, wood waste and its management is vaguely explained and no proper record is

kept of it, according to existing reports. Wood waste falls into the category of non-hazardous industrial waste, where it requires a more detailed record [1, 2]. Even if every company is obliged to keep track of them by the authorities, this information is not taken over by the state institutions. In the European Union, wood waste management is much more efficient, as it is in the territory of Sweden or the United Kingdom, where the legislation is well regulated [11, 13].

According to Decision no. 2293 of December 2004, [3] wood waste was divided into three categories, but it is much better classified according to HG 856/2002.

The wood resulting from the categories mentioned in the law and not only, must be sorted and transported to the storage and utilization units. The sorting is done according to the process from which the waste results, because it may also contain other residues that require a different treatment such as: metals, paints, heavy metals, glues, plastics, varnishes [4].

Wood waste must be stored in spaces designed for this purpose, such as sheds or concrete sheds, avoiding storage on the ground. They must be supervised, because it can be a factor of pollution through the

processes of putrefaction or fermentation, production of leachate, can harbor pests and is an easily flammable material. For these reasons, and because it is easy to recover, on a European level, landfill storage is restricted [6, 7, 15]. In Romania, the main form of valorization of wood waste is burning or using it as a raw material in the production of wood. It is less used for obtaining coals, in animal husbandry, obtaining compost, biogas or for smoking coffee and fish [10].

The wood waste resulting from the production process is usually burned in the company's thermal power plants to obtain thermal energy, raw material for the pile and its transformation into briquettes and pellets (they have a higher calorific value than raw wood).

Wood waste can have many destinations and can be used without affecting the environment through their degradation [8, 9, 14]. At the present time in our country, unfortunately, the chain of wood waste recovery cannot be optimized. Recent data shows that everywhere in Europe, improper storage of this waste and illegal burning generate pollutants such as dioxin. Among the economic agents in the city of Reghin, wood waste represents 29% of the non-hazardous waste generated by industrial and commercial companies with more than 10 employees. Of these, 61% are used as raw material in the paper and construction panel industry, 28% are used as fuel in the form of briquettes or pellets, and 11% are stored at landfills or destroyed improperly. The resulting waste that does not belong to the hazardous waste class (treatment with creosote or varnishes containing heavy metals) can be recycled [16, 24].

MATERIALS AND METHODS

This paper selected a few case studies of waste management which were solved using specific solutions.

A part of them regard the management of waste resulting from forest industry (wood waste management).

In this respect, it is given the example of 11 companies whose activity is wood processing, where the waste is sorted and collected in the

production sections where it comes from. Paper and cardboard packaging is collected in boxes designed for this purpose. Mixed municipal waste is collected in bins at the workplace, and the bins are emptied into 4 cubic meter metal containers, which are then collected by the local sanitation company.

Sawdust is collected and transported to the storage from the thermal plant through the exhaust system. Sawdust, board scraps and veneer are collected at the generation site in wooden crates and then manually transported and dumped into the waste trailer located next to the section, the trailer being then transported by the ifron to the wood waste dump at the thermal plant. Ash residues from combustion and slags from incineration are collected in metal containers of 4 cubic meters, they can be transported with the garbage truck. They are transported to the transfer station and sorting hall in Reghin.

The other types of waste are collected in metal containers of 200 liters, they being made up of paint and varnish waste containing organic solvents or other dangerous substances and absorbents, filter materials (including oil filters without any other specification), polishing materials, protective clothing contaminated with other hazardous substances, hydraulic oils and other engine, transmission and lubricating oils. They are taken over by a specialized company, S.C. Ro Ecologic Recycling S.R.L. located in Vidrasău (Ungheni city, Mureș County).

Domestic water and sludge from adhesives and glues reach the Reghin sewage treatment plant (Reghin Municipality/Mureș County).

Another part of waste management regards agriculture offering examples of solutions found to increase production, animal health and wellness, and protect environment.

RESULTS AND DISCUSSIONS

Waste management- Case studies from wood industry- recovery in thermal energy

Following the study of the 11 economic companies dealing with wood processing in the city of Reghin (Fig. 1), we obtained the following results: in the technological flow, after the wood enters the factory, it goes

through a complex technological process, from each stage from raw material to finished product, waste results. Much of the waste results from timber processing activities: drying, sawing, splitting, sawing, planing, calibrating, profiling, milling, drilling and grinding, generating: sawdust (Photos 3 and 4), dust, wood chips, sawdust, board and veneer scraps.

As a result of wood processing, a larger amount of wood waste results than the amount of wood in the finished product.

From these activities remains, on the one hand, waste, on the other, wood dust (from very softwood, hardwood and composites) that can cause serious ailments, especially to the respiratory system.

Finishing, gluing and painting activities follow.

Through the activity of gluing solid panels and furnishing of pal panels, it generates sludges of adhesives and glues.

When finishing, surfaces that are not uniform are grouted and sanded resulting in mineral or chemical waste depending on what the grout contains.



Fig. 1. Economic agents carrying out activities in the wood industry in the city of Reghin, Mureș county
Source: google.com.

Various oils result from the use of many machines and machines.

The activity of painting with varnishes and paints generates waste of paints and varnishes with a content of organic solvents and absorbents, filter materials (including oil filters, without other specification), polishing

materials, protective clothing, contaminated with dangerous substances.

These wastes contain chemical agents very dangerous for humans such as: methanol, toluene and xylene in the case of solvents or formaldehyde and isocyanates.

Table 1. The quantities of waste generated in 2021 according to HG 856_2002.

Waste type	Measurement unit	Quantity
20 03 01 Mixed municipal waste	Ton	25,680
03 01 05 Sawdust, shavings, shavings, scrap wood and veneer, other than those specified in 03 01 04	Ton	638
08 04 12 slurries of adhesives and glues other than those specified in 08 04 11	Ton	2.4
20 01 02 glass	Ton	0.052
15 01 01 paper and cardboard packaging	Ton	1.34
19 01 12 fly ash and slag, other than those mentioned in 19 01 11	Ton	11.1
08 01 11 waste paints and varnishes containing organic solvents or other dangerous substances	Ton	4.15
15 02 02 absorbents, filter materials (including oil filters not otherwise specified), polishing materials, protective clothing contaminated with hazardous substances	Ton	0.137
13 02 08 other engine oils, lubrication transmission	Ton	0.005
13 01 13 other hydraulic oils	Ton	0.015
Total	Ton	682.879

Source: S.C. Amis Mob S.A.

The place and the conditions of waste storage within the analyzed companies.

Mixed municipal waste is stored (Photo 6) in metal containers of 4 cubic meters that can be transported with the garbage truck, the containers are placed in a box surrounded by a fence and has a concrete platform (Photo 1, 2 and 5).

Adhesive and glue sludges are collected in an underground concrete basin.

Glass waste is stored in 200 liter metal drums located inside the finished product warehouse.

Paper and cardboard packaging is stored in a special box intended for this purpose, located inside the warehouse of finished products.

Combustion ash and slag are stored in metal containers of 4 cubic meters that can be transported with the garbage truck, on the concrete platform next to the thermal power plant.

Used oils are stored in metal drums of 200 liters in the oil store.



Photo 1. Storage shed, outside the building
Source: Original S.C. AmisMob



Photo 2. Building with central, exterior
Source: Original S.C. AmisMob.

Waste paints and varnishes containing organic solvents and absorbents, filter materials (including oil filters without other

specification), polishing materials, protective clothing contaminated with hazardous substances are stored in 200-liter metal barrels in the hazardous waste warehouse.



Photo 3. Sawdust storage inside the shed
Source: Original S.C. AmisMob.



Photo 4. Sawdust storage, inside the shed
Source: Original S.C. AmisMob.



Photo 5. Storage of wooden waste of various sizes, inside the shed
Source: Original S.C. AmisMob.

The wood waste (sawdust, shavings, shavings, board and veneer scraps) is stored in the shed next to the own thermal plant (Photo 7). The shed is a construction with metal poles, a tin

roof, surrounded by masonry and with a concrete floor.



Photo 6. Storage of large wooden waste, outside
Source: Original S.C. AmisMob.

Methods of energy recovery of waste: wood at commercial companies in the city of Reghin: Wood waste (sawdust, shavings, shavings, scraps of boards and veneer) is used by burning in the boilers of the thermal plant, in order to produce the thermal energy needed to heat the production spaces and dry the timber in the drying facilities (Photo 8). These drying facilities are rooms made entirely of non-oxidizing metals and insulating material (mineral wool), the timber is dried through a ventilation system and pipes that carry out the heat transfer. The whole process is coordinated with the help of software.

Large-sized wood waste goes through a shredding and chopping process (Photo 9). The other types of waste are taken over by authorized companies.



Photo 7. Central heating
Source: Original S.C. AmisMob.



Photo 8. Lumber drying plant
Source: Original S.C. AmisMob.



Photo 9. Equipment for shredding large-sized wood waste
Source: Original S.C. AmisMob.

Case study: Wood waste management within the company S.C. *OlteanProdlemn* S.R.L.

Through this study, we aimed to highlight the management and utilization of waste from the factory of wood products (beams, boards, brewery sets, pellets, etc.) S.C. *OlteanProdlemn* S.R.L. As a result of production, a series of waste categories result, which for the most part, quantitatively speaking, is represented by wood waste, followed by household waste, rubber, metals, used oils, glues, paints, chemicals, ash combustion and slag. In order to reduce costs and increase production, wood waste is reintroduced into the technological cycle and utilized in the form of thermal energy, but also processed into pallets and briquettes, which are then sold.

The production activities that generate waste are, just like those of the S.C. Amis Mob S.A. factory, namely: drying, transport, cutting, splitting, cutting, planing, calibrating, profiling, milling, drilling, grinding, but also

the other operations are waste generators such as: varnishing, painting, gluing, etc.

Case study: Methods of collection and storage of wood waste within the company R.A.G.C.L. Reghin S.A.

The waste is sorted and collected in the production sections, from where it is then transported to the storage site according to its type and use. These wastes are represented by metals, glass, paper, cardboard, plastic, tires, household waste, etc.. They are then taken over by R.A.G.C.L. Reghin S.A.

The sawdust and dust is collected and transported to the storage site by means of the exhaust plant. Larger wood scraps (board scraps, veneer, sawdust, shavings, etc.) are collected in containers, then transported by forklift trucks to the place of storage.

The storage place is represented by a shed near the thermal plants and the pellet production hall.

Combustion ash and slag are stored in transportable metal containers.

They are picked up and transported by an authorized company.

The other types of waste are collected in barrels and metal containers, these being represented by glues, organic solvents, paints, varnishes, oils, and other hazardous waste. They are sent to a warehouse specially designed for hazardous waste.

Table 2. The quantities of waste generated, recovered and stored in 2021, wood waste by month

	Month	Waste quantity (t)		
		Generated	Recovered	Remaining in stock
1	January	419	234	185
2	February	373	278	95
3	March	495	423	72
4	April	223	148	75
5	May	75	0	75
6	June	305	230	75
7	July	365	317	47
8	August	348	302	46
9	September	315	267	47
10	October	340	276	64
11	November	375	284	91
12	December	347	299	48
	TOTAL	3.980	3.058	920

Source: S.C. OlteanProdlemn S.R.L.

They are taken over by an authorized company called: S.C Nida Eco S.R.L. The

quantities of waste collected by category are presented in Tables 2-8.

Table 3. Amounts of sawdust generated in the year 2021 (t)

	Month	Waste quantity (t)		
		Generated	Recovered	Remaining in stock
1	January	150	108	42
2	February	120	120	0
3	March	189	189	0
4	April	75	75	0
5	May	0	0	0
6	June	113	113	0
7	Iulie	170	170	0
8	August	105	105	0
9	September	155	155	0
10	October	125	125	0
11	November	166	166	0
12	December	121	121	0
	TOTAL	148	1.447	42

Source: S.C. OlteanProdlemn S.R.L.

Table 4. Amounts of metal generated in the year 2021 (t)

	Month	Waste amount (t)		
		Generated	Recovered	Remaining in stock
1	January	0	0	0
2	February	0	0	0
3	March	0	0	0
4	April	0	0	0
5	May	0	0	0
6	June	0	0	0
7	Iulie	0	0	0
8	August	0	0	0
9	September	0	0	0
10	October	0	0	0
11	November	2.75	0	2.75
12	December	0	0	0
	TOTAL	2.75	0	2.75

Source: S.C. OlteanProdlemn S.R.L.

Table 5. The quantities of household waste generated in 2021 (t)

	Month	Waste quantity (Kg)	
		Generated	Eliminated
1	January	150	150
2	February	112	112
3	March	145	145
4	April	116	116
5	May	125	125
6	June	110	110
7	July	95	95
8	August	86	86
9	September	123	123
10	October	133	133
11	November	106	106
12	December	111	111
	TOTAL	1.412	1.412

Source: S.C. OlteanProdlemn S.R.L.

Table 6. The quantities of tires generated in the year 2021 (bucati)

	Month	Waste quantity (per piece)	
		Generated	Remaining in stock
1	January	0	0
2	February	0	0
3	March	0	0
4	April	0	0
5	May	0	0
6	June	0	0
7	July	0	0
8	August	2	2
9	September	0	0
10	October	0	0
11	November	3	3
12	December	0	0
	TOTAL	5	5

Source: S.C. OlteanProdlemn S.R.L.

Table 7. The amounts of ash and slag generated in the year 2021 (t)

	Month	Waste quantity (t)	
		Generated	Eliminated
1	January	0.15	0.15
2	February	0.17	0.17
3	March	0.12	0.12
4	April	0.18	0.18
5	May	0.16	0.16
6	June	0.15	0.15
7	July	0.14	0.14
8	August	0.13	0.13
9	September	0.11	0.11
10	October	0.20	0.20
11	November	0.18	0.18
12	December	0.19	0.19
	TOTAL	0.188	0.188

Source: S.C. OlteanProdlemn S.R.L.

Table 8. Amounts of used oils generated in the year 2021 (Kg)

	Month	Waste quantity	
		Generated	Eliminated
1	January	35	35
2	February	40	40
3	March	66	66
4	April	70	70
5	May	50	50
6	June	0	0
7	July	110	110
8	August	44	44
9	September	81	81
10	October	91	41
11	November	60	60
12	December	44	44
	TOTAL	651	651

Source: S.C. OlteanProdlemn S.R.L.

Waste management-Case studies from agriculture

A large part of waste represents biodegradable wastes consisting of organic matter of vegetal and animal origin.

It is about:

- vegetal biomass including various crops, straw, roots, tress leaves, seeds, energetic crops like rape, maize, sunflower;
- animal waste, including solid manure and purine;
- industrial waste: food waste, waste resulting from beer, sugar, wine, milk, alchool, milling industry;
- forest waste;
- commercial waste: textiles, paper etc.
- household waste etc.

A high attention is paid to solutions which are included in regenerative agriculture which maintains environment qualities (soil, water, air).

A few examples of case studies in waste management in agriculture are presented below.

(a) To maintain soil quality and biodiversity, a high production level and a low production cost, the Spanish farmers growing strawberries started to implement organic agricultural practices replacing the plastic waste with biodegradabil paper and pest control was ensure by bioplants [18].

(b)In dairy farming, the use of a supplement of fat in cows diet, has led to a higher milk yield andfat, and to a benefic effect on cows health and reproduction [19].

(c)In Spain, the efficiency of land use was increased by improving the nutrients offered to crops, reducing greenhouse gas emissions and increasing dairy cows yield. For this purpose, manure was combined with mineral fertilization bazed on Selenium and Sulphurus, resulting a higher grass production, a better feeding for cows and a highr milk production per ha. More than this, gas emmissions were reduced by Carbon incorporation into the soil [20].

(d)Rotation grazing was optimized by establishing a plan of grassland use by rotation and improving the floral composition with additional species during summer season. In this way, the length of grazing was longer and costs were reduced, but milk production declined [21].

(e)In France, using special enzymes in dairy cows diet to stimulate the digestion of the food rich in starch and fibres, it was increased

milk yield and fat, milk quality and animal health and fertility [22].

(f) In Spain, Fruites Caberol produces and sells a large variety of fruits (cherries, apricots, nectarines, peaches, pears and apples) which are achieved by respecting the global norms regarding sustainable agriculture oriented to a high product quality and also preserving the quality of the environmental factors [23].

CONCLUSIONS

Wood waste (sawdust, shavings, shavings, scraps of boards and veneer) can be used as energy by burning in the boilers of the thermal plant in order to produce the thermal energy needed to heat the production spaces and dry the timber in the drying facilities. Drying facilities are rooms made entirely of non-oxidizing metals and insulating material (mineral wool and other insulating materials), where the timber is dried through a ventilation system and pipes that carry out the heat transfer. Large wood waste can be chopped for use in power plants.

The waste intended for the production of pellets and briquettes is chopped, shredded and pressed with the necessary equipment. As well as their packaging machines for the purpose of preparation for marketing.

The utilization of wood waste has a positive impact on the environment because:

- they are easy to store;
- the burning process is clean compared to some petroleum fuels (results in less harmful emissions);
- comes from a renewable resource;
- more economical than fuels and gas;
- reducing air, water and soil pollution by reducing inappropriate storage areas;
- protecting water, air and soil through good management;
- ecological fuel can be produced from biomass, replacing petroleum ones.

But the capitalization also has disadvantages such as:

- requires large storage space;
- requires an expensive manufacturing process and labor;
- continuous supply of raw material.

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