

# WASTE SEPARATION AND RECYCLING METHODS, WHICH ARE THE MOST SUITABLE FOR CITY OF NOVI SAD

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## Abstract

Besides solid waste classifications and quantification, very important role have determination of technology that could be the most efficient waste treatment method, as well as determination of recycled material market cost.

Cost benefit and fusibility study are necessary in the first stage of determination which method, or combination of methods, are the best for the local conditions. For example total amount of waste in Novi Sad estimate 272 tonnes per day, and 99280 tonnes per year.

Importance of cost benefit and fusibility study is great because theoretical comparison could influence process of decision-making. Also, local conditions always favourite methods which are more suitable and efficient (e.g. in some conditions better effects are achieved with method which is combination of recycling and paralysis than with combination of recycling - composting or incineration - deposition).

In the recycling process a great role have waste classification and primary selection by type of waste (e.g. paper, PVC, textile), by morphological composition (in Novi Sad paper estimate 13.5%, organic material even 65.8%, metal 2%, PVC 11.5%, ...).

Waste classification could be also done visually, by magnetic tests, microscopic analysis, etc.

## Introduction

Municipality of Novi Sad and Petrovaradin comprises the area of 699,2 km<sup>2</sup> which is the 3.25% of Vojvodina's total area.

In 1996. in 15 settlements there were 294,244 inhabitants. On the basis of the projection which was done for the General Plan of Novi Sad (2000-2021) it was predicted that on the same area it going to be 321700 inhabitants, which is in comparison with the status in 1996., greater for 24 500 inhabitants. It is important to stress that in this projection were not included frequent migrations that were happened during the last decade as consequence of the war in former Yugoslav republics. On the area of Novi Sad and Petrovaradin municipality there were 110000 employed people, of this number 15% have lived out of border of mentioned municipalities.

This kind of activity structure is reflection of social and economic position of Novi Sad in Autonomous Provincial Vojvodina. Namely, the most parts of Vojvodina incline to the Novi Sad. But in last decade (1992-2002) economic capacities of Novi Sad were alerted by influences of present conditions (war, market, embargo, NATO intervention) that also affected the people's living standard, bulk of investment, and work of JKP "Cistoca".

## Methods

In this paper it is presented analyses of present solid waste management system that are suitable for Novi Sad.

Table 1. Structure of solid waste of Novi Sad

Components	Average amount		Structure (%)
	Day	Year	
Paper	36.5	133323	13.5
Glass	4.0	1460	1.5
Plastic material	32.1	11714	11.5
Metals	5.3	1935	1.9
Gum	1.7	621	0.6
Draperly	5.9	2154	2.2
Organic waste	178.4	65116	65.8
Other	8.1	2957	3.0
<b>Total</b>	<b>272.0</b>	<b>99280</b>	<b>100.0</b>

Table 2. Projected solid waste quantity and total solid waste quantity

Year	Average daily solid waste quantity per inhabitant (kg)	Total solid waste quantity per year (t)
2001	0.90	99280
2006	0.96	112000
2011	1.04	123000
2016	1.12	132000
2021	1.20	141000

## Results and Discusions

Besides solid waste classifications and quantification, very important role have determination of technology that could be the most efficient waste treatment method, as well as determination of recycled material market cost.

On the basis of the quality and quantity of solid waste analyses, in this papers are shown the types of solid waste treatments, which could be suitable for Novi Sad.

### Separation

Solid waste separation takes important place in the whole solid waste management system. Separation could be primary or in the special facilities on the landfill for waste disposal. Primary separation is theoretical better solution because there is no mixing of incompatible materials as well as spotting of material that could be used for recycling.

However primary separation have it disadvantages. First of all there are no enough motivation and ecological education among the most citizens. Second, often there are need for investment into different types of bags and containers (for plastic, paper, glass, ect.).

Problem for this solution goes into two directions:

1. Specific facility cost is extraordinary big because of small quantity of generated solid waste. This kind of facility is payable for large cities as Roma, Mexico City, ...
2. As country in transition period has no enough money for sub venting of recycled row material, recycling process is not profitable.

For small towns like Novi Sad is, the best solution is the stations for collection of primary separated solid waste. The station could be placed on different locations all over the town. Example of this kind of stations one can meet in Pecuj, Hungary. The whole process of separation is very simply organized: citizens brings their separated solid waste into collection station, because there is no other place for depositing of solid waste in the town, and then with help of educated worker sort it into special containers.

Treatments of waste, cutting, baling and transport of the solid waste to the recycling facilities, could be also organised on this kind of station.

Illustration 1: Station for primary separation of solid waste



### Recycling

The basic dilemma in process of recycling is where to place this kind of facility. Is it better to be placed in the same place where is the separation, or near the facility that uses the separated material as raw material?

Recycling facilities built on landfill for waste disposal and production of the primary raw material in most cases are more expensive than treatment of solid waste (separation, cutting and balling) and transport to the facilities for producing the final product.

Table. Savings that could be realized by switching from primary to secondary raw material.

	Paper	Glass	Steel	Aluminium
Energy	23-74	4-31	47-74	90-97
Aero pollution	74	20	85	95
Water pollution	35	-	76	97
Mine waste	-	80	97	-
Water consumption	58	50	40	-

Average recycling degree of certain solid waste components

Paper	34%	Glass and ceramics	37%
Drapery	40%	Gum	19%
Plastic material	26%	Metal	99%

### Plastic material

Of total amount of solid waste produced in Novi Sad, 32,1 t/day or 11714t/year (11,5% of total amount) is plastic material.

It is very hard to determinate recycling technology for this type of waste. Process for plastic recycling needs very pure raw material.

Nowadays there are manufacturers who created equipment with characteristics independent of raw material quality.

Capacity of this equipment could be from 200 - 2000 kg/h. As estimated production of plastic waste is 1500 kg/h, this equipment could give good results for Novi Sad, only in case if primary plastic selection is present.

### Glass

Average production of waste glass in Novi Sad is 4t/day, apropos 1460t/year that is 1,5% of total amount of solid waste produced in Novi Sad. Solution for Novi Sad, which could give good results are automatic systems for glass separation with capacity of 4 t/day.

In Belgrade in 1992. There was a pilot project for primary glass separation. Both quantity and quality of separated glass were good: in period April – October it was collected 47 t, apropos 1200 kg/container. Alongside that, detailed analyses of citizen's relation to the project as well as efficiency of containers dislocation properly to the number of habitants was conducted.

General conclusion of this pilot project was that the primary glass separation in Belgrade, with simultaneously citizen's education and motivation, gives better results than separation in facilities on landfill for waste disposal.

Unfortunately, there was no financial possibilities for continuing of this project.

#### Paper

Basic paper types that could be recycled are old newspapers, cardboard, highly quality paper used for printing of exclusive tabloid paper, and other kinds of paper used for household work.

Novi Sad waste paper production per year is 13323 t, which is 13.5% of total produced amount per year.

Illustration 2: Manuel facilities for on-site separation



Paper of higher quality could be used as replacement to the basic raw material, celluloses, while less quality paper could be used for production of cardboard, toilet papers etc.

Recently, in Novi Sad there was a Paper Service which basic activity was collection, rather buying waste paper, baling and selling to certain companies in Yugoslavia. Economic problems which comprised Yugoslavia in period of last decade, showed its effects on Paper Service work, too. Namely, equipment became old, waste containers were abused by other, illegal, collectors, who were collecting papers and sell it to the Paper Service, charge of recycled paper was not controlled nor subvented by Government. Whole this situation resulted that Paper Service is on the edge of existence.

As institution with a lot of experience and educated cadre Paper Service should be included and helped by Government to take own place in solid waste management system.

#### Metal

Quantity of waste metal production in Novi Sad is 700 – 800 t /year or 2% of total produced amount.

The great amount of produces waste metal is separating in Novi Sad by illegal, but acceptable and useful collecting by people who found it as good source of money.

In Novi Sad there are companies which buys waste metal, melt and sell it to the other companies which uses it as raw material for final product. So in this case it is not necessary to invest in treatment facility but in more quality primary separation.

#### Gum

In Serbia and Montenegro waste gum is usually treated as solid waste.

Waste gum is totally nonrentabile material for recycling, because production of waste gum is 621t/year or 0.6% of total amount of waste produces in Novi Sad. Percent of produced waste gum per year in much bigger because of great quantity of vehicle waste gum. Quantity of waste gum that could be rentable for recycling it is possible to obtain by mixing of industry waste gum and other types of waste gum and its balling and transporting to the companies that already uses this waste gum for final products.

## **Conclusions**

In previous text it was not included Environmental aspects of waste separation and waste recycling importance but only economic aspect, and aspects of technical possibilities and rationalities.

In following text it is given what are the main environmental aspects of solid waste recycling. Before all it is important to stress the aspect of sustainable development on local and national level. Aspect of energy saving is also important because the producing of energy is one of the greatest environmental source of pollution. Recycling could be process which could save energy and give smaller environmental pollution as well.

By rehabilitation of old landfill for waste disposal and with appropriate waste management, building of new ones would not be necessary.

With good recycling system and primary selection as well as citizen's motivation it would be possible to reduce quantity of produced waste and deposing on inappropriate places.

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