Waste Management – A Component of Territorial Planning

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Abstract
The European Spatial Development Perspective (ESDP) adopted by the countries of the European Union in 1999 is the model document on which the urban development strategy in Romania has been based. The objective of spatial planning and organization is to identify the right relationship between the natural environment and human activity with the aim of improving the community's life conditions. The main objective of territorial development strategies is to increase urban comfort. The comfort of urban localities is conferred by the quality, the technological performance of town infrastructure. In this context urban waste management occupies a central place. Ecological waste management contributes to the protection of the environment, and of public health.

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The Romanian Law for Territorial Arrangement and Urbanism[1] has defined development strategy as the direction of the actions meant to determine urban development either globally or according to activity domains on a short, medium, or long run.

Urban development is a component of regional development, a set of policies elaborated by central and local public administration with the aim of harmonizing sectoral development strategies, policies, and programmes according to geographical areas in the spirit of lasting development, and to satisfy present demands without compromising future generation's right to existence and development.

The strategy of urban development is included in the European Spatial Development Perspective (ESDP) adopted by the countries of the

[1] Law No. 350/2001.

European Union in 1999 and it is based on the application of the following principles: lasting development, balanced competitiveness, social cohesion, urban renovation and a better government.

Urban structure represents the way in which a settlement or an area of this is formed, grouped or organized historically, functionally, and physically. A settlement is defined by its administrative and inner area. Administrative territory as a general notion designates a geographical space, a plot of land delimited by law, organized according to the different levels of territorial administrative organization: national, regional, county levels, and the levels of territorial administrative units: cities, towns, and villages. At the present moment, the administrative territory of an urban settlement is delimited from the administrative territory of the adjoining villages.

The inner area consists of the entire built-up territory of a settlement (of the settlements forming the basic administrative-territorial unit), delimitated by the general urban plan, within which buildings can be erected. The inner area may be compact, unified, or may be formed of several bodies (component villages or suburban localities).

The outer area is the territory situated between the administrative-territorial boundary and the limit of the inner area.

The metropolitan area is the territory situated around great urban agglomerations, delimitated by specialist studies, within which mutually influential relationships flourish in the domains of economy, demography, culture and technical-urban infrastructure. The boundary of the metropolitan area is usually beyond the limit of the city's administrative territory; it may even pass the administrative boundary of the county. The development of metropolitan areas is closely related to regional development.

Within the region, urban development poles are ranked according to their area of influence, and the intensity of the relationships in the network of settlements.

The network of settlements consists of urban/rural settlements, and the economic, demographic, service, political-administrative, etc. connections.

The development of an urban settlement is based on the following factors: the development of human, economic, social, and cultural resources; the restoration, conservation and valorisation of the natural and ecologic heritage in harmony with human activity; the identification of the initial environmental state and the quantification of foreseeable incidents; the arrangement of the territory realized by the implementation of some harmonious, therefore coherent relationships between the different territorial components: city, rural are, technical-urban (magisterial) infrastructures, etc.; the attraction of some high metropolitan functions generating income; and the development of public services generating new jobs.

Within settlements *functional interest areas* and *protected areas* are differentiated.[1] The former are characterized by homogeny and functional coherence, usually defined by the general urbanistic plans; the latter are delimited territories around some parts of the built or natural heritage, some natural resources, water courses or surfaces in which restrictive measures are implemented by (distances, functionality, height, and volume) in order to protect public health, the environment and the natural and built heritage. (L350/2001)

A *reference territorial unit* (*RTU*) is an urbanistic subdivision of the basic administrative-territorial unit's territory, constituted on similar or homogenous urbanistic criteria aimed at the conservation, restoration or development of the territory in accordance with the community's traditions, values, and aspirations at a given moment, and necessary to gather population and construction indicators to restricted areas, to determine urban characteristics, to establish urbanistic indicators, and to carry out homogenous urbanistic regulations. The surface of a reference territorial unit is usually 1.0–20.0 ha, and, in exceptional cases, 100.0 ha. The delimitation is made along ownership lines, according to the similarity of the relief and landscape, the unitary historical evolution in a certain period, the population's homogenous structure, the parcelling system, the homogenous way of construction, the similar use of lots and constructions, as well as the similar legal system of real estates (site + constructions).

With respect to natural resources, climatic conditions and human potential, we may state that settlements do not have a range of influence, but complex areas (geographical area, plus anthropic actions) create and offer vital area of development, and the (recoverable and unrecoverable) resources for the settlement.

Implicitly, the (main) settlement organizes the territory, the "periurban" area, institutes programmes for land improvement, applies new technologies, and protects the environment; these actions are efficient, affirmed, or invalidated on the same time coordinate.

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[1] Decision of the Romanian Government No. 525/1996, for the ratification of the General Regulations of Urbanism.

The natural and human resources, economic and social interdependence, communications, transports, technical equipment generate "network" type relationships between settlements, in other words, they generate viable urban systems. Geographic support and resources have a central role in generating urban systems and in making them viable (seaside, defile, and communication axis types of conurbations).

One of the main objectives of territorial development strategies is to increase urban comfort. The comfort of an urban settlement is conferred by the urbanistic infrastructure meant to ensure the maximum functionality of each property (lot plus building).

Substituting functionally a settlement for a complex, properly furnished real estate property, the issue of urbanistic infrastructures is extended to a superior level (territorial, areal, regional). The settlement will be supplied with water from surface waters (lakes, rivers with hydro-energetic equipments, springs), or from the phreatic zone (drains, wells), being necessary to cleanse the water in order to become drinkable, to transport, store and distribute it to consumers.

Used water must be gathered, transported, treated, purified and reintroduced into the natural circuit, while sub-products must be reused (mud as natural fertilizer).

The settlement is supplied with electric energy for public lighting, local lighting, transport (trolley buses, underground), and energy consumption. The settlement is thus connected to a regional, national or continental network. An energy producer (hydro-electric power station, thermo-electric power station, atomic-electric power station) and a way of transport (high tension networks) must be chosen; the transformation of high tension energy into consumable energy (to medium and then to low tension) must be resolved; and a network distributing the energy to consumers must be created.

The thermal energy necessary to a settlement is currently produced from natural fuels (solid, liquid, or gas) by transforming fossil energy (or other energy forms) into caloric energy, and then it is transported and distributed to the consumers.

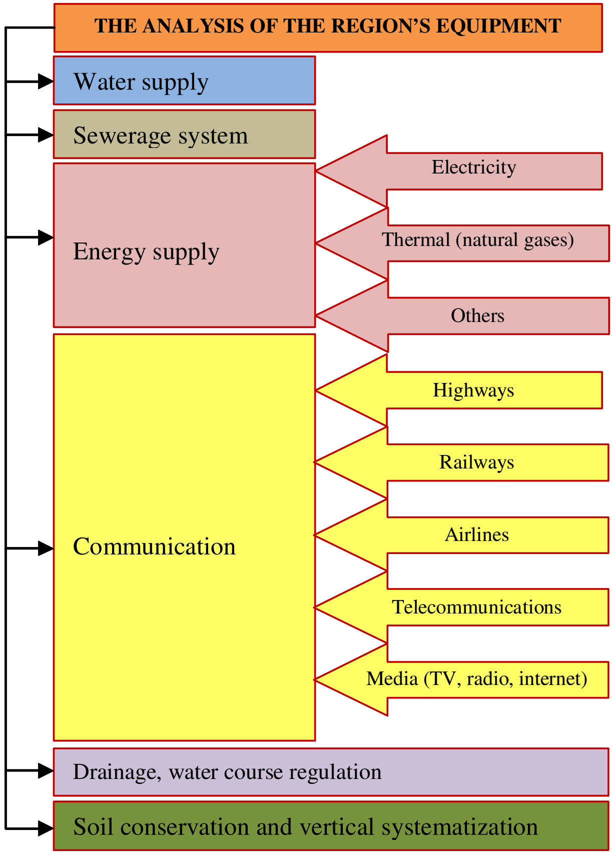
The settlement is connected to the local, zonal, regional, national or continental system through transport lines: terrestrial, aerial, marine or fluvial according to the case. The speed of transport and the necessity of fluent communication lead to the creation of some modern road networks, high speed routes, expressways, high-tech railways, ports, airports, underground transport networks.

A raw material and energy consumer, governed by the autocracy of automobiles, the city is a pollutant affecting the soil, the subsoil, the phreatic waters, and the atmosphere. To these noise pollution and light pollution are added, all these pollution types oscillating in amplitude from the discomfort limit to being a danger to public health.

Urban household waste, street waste and industrial waste require appropriate measures of collection, transport, storage (ecological sites), sorting, and processing, as well as for reintroducing recovered materials (glass, metals, plastic masses, rare metals, compost) into the consumption circuit.

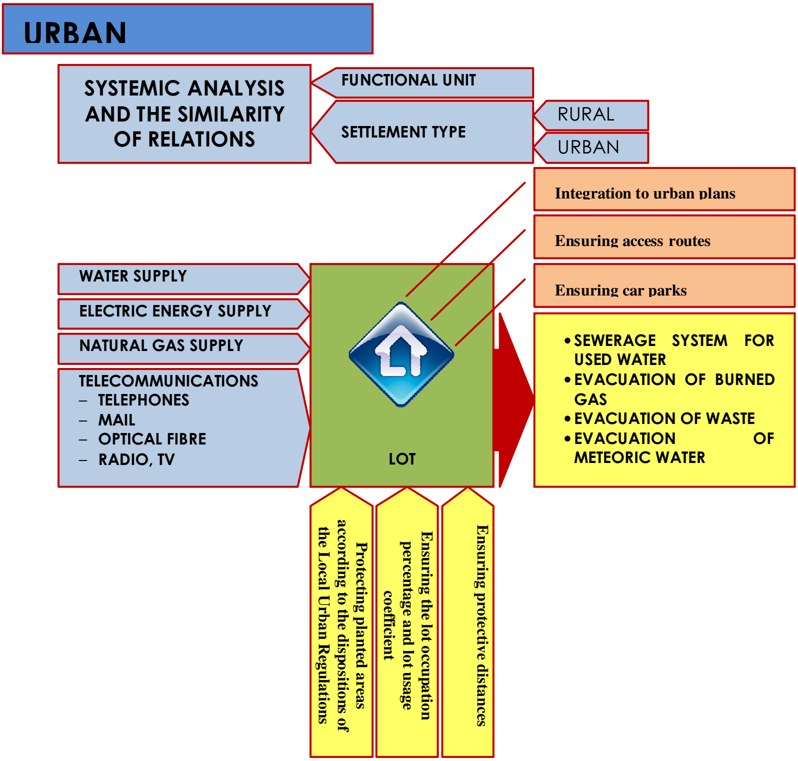
In the complex process of urban management the cleanliness of settlements has special importance. Urban development causes the production of ever increasing quantities of household, industrial, and street waste. Their unsupervised collection, disposal, and transport may cause serious environmental pollution (water, air, and soil pollution), and it may lead to the proliferation of micro-organisms and the multiplying of rodents. Resolving the problems related to these activities, as well as neutralizing residues on scientific bases contributes decisively to environmental protection. The valorisation of urban waste constitutes at the same time an important raw material and energy source by reintroducing it into the economic circuit. The quantity and quality of urban waste depends on the population's life standard and consumption habits, while industrial waste – both dangerous and harmless – depends on the technologies used to process raw materials during the production process. At a European level one may observe that Romania and other Central and Eastern European countries are confronted with the same waste problems as the western countries of the European Union encountered 15–20 years ago.

Waste statistics was introduced in Romania between 1993 and 1995 on the basis of a Romanian Waste Catalogue following the model of the European Waste Catalogue, applied since 1995, though the normative act came into force only in 1999. According to statistics at a European level the yearly waste quantities decreased from 353 billion tonnes in 1995 to 55 billion tonnes in 2000. As a comparison, in the European Union the total waste quantity was estimated to 3.5 tonnes/inhabitant (without quantifying agricultural waste) in 1995, while in Romania a quantity of 15.5 tonnes/inhabitant was recorded, therefore a 4.4 times greater quantity. In 2000 the total waste quantity produced in Romania falls considerably (to 2.45 tonnes/inhabitant), a phenomenon also recorded in the countries of Central and Eastern Europe in which the index fell from 8.7 tonnes/inhabitant to 5.2 tonnes/inhabitant, which represents a decrease of approx. 40%.



The total waste quantity represents on the one hand the efficient use of natural resources, on the other hand the relationship between production and consumption. We may deduce how efficiently natural resources are used by comparing the level of industrial production to the population's consumption level; that is, comparing production waste quantities to urban waste quantities. The decrease in the relation of these values is determined by the decrease of industrial production, and also by the better use of natural resources.

As compared to Central and Easter European countries, Romania occupies a middle position being behind Slovenia, Bohemia, Lithuania, but before Estonia and Bulgaria. This indicator is a few times higher than in the countries of the European Union with a "post-industrial" economy, in which the production/consumption relation is low (0.95 in Holland, 0.96 in Denmark, 3.5 in France). This can be explained by the use of "clean" technologies, internal recycling, and a reorganized industry. Raw material and energy import, as well as the closing down of some branches of heavy industry during the last decade contributed decisively to the regulation of this relation.



The notion of urban waste comprises the totality of waste produced in urban and rural environment by households, institutions, trade, and services, street waste collected from public spaces (streets, parks, greenspaces), and mud coming from used water purification stations. In Romania the indices of urban waste production were 293 kg/inhabitant/year, and 0.80 kg/inhabitant/year for 1995, increasing to 0.96 kg/inhabitant/year according to the centralized data for 2000. The percentage of urban waste components is estimated to be over 2/3 of the total waste quantity, consisting of household waste (75–80%), street waste (10–12%), mud from purification stations (7–9%), materials from demolitions, excavations (3–4%), etc.

In the total amount of household waste the quantities of wrappings (plastic, paper, glass) increased, and the quantity of alimentary and inorganic waste decreased; this means a considerable increase in calorific power and a decrease in humidity.

Household and street waste are collected and transported separately. Household waste coming from private houses, as well as industrial and commercial economic units is pre-collected in special recipients of different types and dimensions. In the year 2000 at a national level it was estimated that a number of approx. 500,000 recipients were in use. From these recipients placed in specially arranged spaces, domestic waste is transported to the storage sites by car: waste collection vehicles, tractors, trucks (in the year 2000 approx. 2000 vehicles were used by cleaning and waste management companies). Street waste is collected and transported by cleaning and waste management companies using special equipments: street sweeping machines and street vacuum cleaners. The system is deficient because there are insufficient recipients, litter bins and special equipment.

The quantity and composition of urban waste is considerably varied, being influenced by the settlement's degree of urbanization, the number of its inhabitants, the season, etc. Urban waste consists mainly of domestic residues, worn out machines, green waste, and waste from water purification. Domestic waste contains compostable materials (food remains, tainted food), combustible materials (paper, cardboard, plastic masses, leather, wood, etc.), incombustible and non-compostable materials (glass, ceramic, stone, metals, debris), other types of waste (ballast, sand, animal carcasses, etc.). Worn out machines are generally voluminous, and they come from household use, hotels or trade. Green waste has varied quantities according to climate, geographical area, the extent of vegetal covering. Domestic residues have a specific weight

(300–400 kg/mc) and humidity (25–60%), and they consist mainly of vegetal waste (approx. 70%) with a high humidity coefficient and a low caloric power (under 900 kcal/kg).

Apart from this, the dangerous waste originating from industry and medical practice constitutes a major problem both from a technical point of view and with respect to the population's environmental protection. One of the traditional methods for processing medical waste was incineration. The advantage of the method is that it can reduce the volume of the waste by 90%, but the resulting ash is in fact a waste with increased toxic concentration, and there is a great danger for this to be rapidly and widely scattered. In fact, incinerators themselves generate waste; the burned material does not disappear, it only changes its form. The chemical reactions that take place during the burning are of a great complexity, resulting in organic compounds whose toxicity is difficult to identify and test. The gases resulting from burning contain great quantities of dioxin, a substance with high toxicity which accumulates in living tissues causing cancer, reducing the efficiency of the immune system, provoking hormonal disequilibrium, diabetes, and genetic mutations. The water which the equipment of the incinerator is washed with is a highly toxic waste, requiring efficient neutralization procedures. The gases emitted into the atmosphere, sodium dioxide and sulphur dioxide contribute to the creation of acid rains and smog, and they affect the ozone stratum. Medical waste contains twice as much plastic material than household waste, their chlorine compound being the main source for the formation of dioxins in the incinerator, and vinyl chloride which plastic materials are made from is a carcinogenic substance. To build an incinerator which would respect environmental norms is an expensive investment, to which the costs of the negative impact on people's health and the environment are added, these being costs difficult to estimate.

An alternative for processing medical waste is the technology of grinding and chemical sterilization.[1] This results in a material similar to conventional solid waste which meets the requirements of environmental regulations. The procedure requires a system which can process up to 75 kg conventional medical waste (syringes, needles, blades, dialysis filters, plastic pipe systems, test tubes, etc.) in only 17 minutes. The system is homologated by the European Community, and it is meant to perform a chemical sterilization process with a 94% biodegradable solution. The

[1] S. C. Ecomed. CO, "Sistem ecologic de eliminare finală a deşeurilor rezultate din activităţile medicale" (An Ecological System for the Final Elimination of Medical Waste).

use of the solution has been sanctioned by the Federal Agency of Environmental Protection of the FRFRA (Federal Insecticide, Fungicide, Rodenticide Act). Grinding and chemical sterilization are done simultaneously, and a monitoring system supervises the phases of the cycle and the operation mode, triggering automatically a protective system if perturbations occur during the procedure. The producers of the system declare that the procedure is highly efficient, reducing significantly the concentration of pathogen elements: vegetative bacteria, micro bacteria, feculence, fungi and viruses. The resulting waste can be evacuated as domestic waste without any dangers at all. While operating the system does not emit radiation or heat; it must be supplied with water and electric energy, and connected to the sewerage. The low energy consumption proves the efficiency of the system which has been conceived to respect the principles of precaution, of environmental risk, and of final storing (the principle of responsibility). Thus it is possible to decontaminate medical waste chemically directly in the health care facilities where it is produced, or by externalizing cleansing and waste management services according to the National Waste Management Plan and the Governmental Programme for Promoting Research and Innovation in the Domain of Waste Management (E7). The latter recommends the orientation of waste management activity towards "the use of some modern technologies for neutralizing and eliminating dangerous waste".

A similar level of circumspection is needed in the case of industrial waste as well. This can be ordinary, special or dangerous. Special waste comes from metallurgy (iron, pig iron, copper, lead, worn out equipment), mining, oil industry and geology (mining waste dumps, mud, slag), the chemical sector (plastic masses, worn out tyres, rubber), timber industry (sawdust, shavings, massive timber refuse), food and textile industry, and agriculture.

Dangerous waste are toxic refuse: solid and liquid pesticides, batteries, storage batteries, tyres, waste industrial oil, plastic masses, slag and cinders, acids, waste from tanneries. There are approx. 28 chemical elements which confer exceeding noxiousness to residues. At the time being these materials are collected and stored in special conditions in city or village storing sites, in settling basins, or in gangue heaps, according to case. There is a considerable amount of dangerous waste; only in Cluj County it reaches 1,500,000 tonnes/year.[1]

The National Waste Management Plan is an instrument by which the policy of the European Union in this domain is introduced in Romania. It contains concrete measures and actions meant to introduce the sorting of recyclable materials at the source and their selective collection until 2010. The transfer station network for the transport of solid urban waste is to be realized until 2017. The Plan also prescribes that an ecological urban waste storing centre is to be created in each county until 2009. The county plans for urban waste management have also been structured according to these lines.

The process of waste management has several stages following one another from the production of the waste to its differentiated valorisation. Primary pre-collection is followed by a secondary stage when waste is gathered on pre-collection sites, and then by the stage when residues are transported to the storing, neutralization, or valorisation locations. The collection of household, street and industrial waste can be open (the content of containers is directly loaded into the waste collection vehicle; with the disadvantage of polluting the environment), or hermetic (the waste is loaded into the garbage trucks by a mechanical lifting system, the container being joined to the loading opening of the truck). An optimal system is to substitute the containers after they have been loaded for other containers washed and disinfected.

Household waste is valorised by recycling, a procedure during which recoverable materials (paper, ferrous and non-ferrous metals, glass) are pre-selected at the source, and reintroduced into the economic circuit. This procedure requires a well organized collection, and quite highly educated waste producers. Another valorisation form is controlled storing, a procedure contributing to the environment's depollution, to the rehabilitation of some degraded lands and their introduction into the agricultural circuit. Composting is a traditional procedure consisting of the aerobe fermentation of residues with a high content of organic substance, and their transformation into compost, a good natural fertilizer. The extraction of food residues and their transformation into animal fodder is another valorisation method. Incineration[2] and pyrolysis are techniques by which thermal energy can be recovered, but they are

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[1] Cluj County Council, *Planul județean de gestionare a deşeurilor* (County Plan for Waste Management), ed. 1/2004.

[2] Nicolae Antonescu et al., *Valorificarea energetică a deşeurilor* (The Valorisation of Waste as Energy) (Bucureşti: Editura Technică, 1988).

expensive methods, and they require high technological equipment. Pyrolysis means thermal decomposition at a high temperature and without oxygen. This procedure decreases the volume and weight of residues, and it results in combustible gases.

In Cluj County the County Plan for Urban Waste Management is being re-actualized, and studies have been made for the optimization of the management system. Presently, waste is stored in sites not fitted specially for this purpose; they occupy a total area of 20.54 ha for the towns of Cluj-Napoca, Dej, Turda, Câmpia Turzii, Gherla and Huedin, with a total capacity of 2 million mc, a quantity of 615,000 mc being deposited there yearly. The quantity of urban waste in the county exceeds 202,100 tonnes/year, consisting of approx. 134,200 tonnes of wrappings and incinerable waste, 44,100 tonnes of organic and inert waste, 13,600 tonnes of street and vegetal waste, and 10,200 tonnes of waste from demolitions, organic and inert waste.[1]

The county programme recommends the establishment of three areal centres for the collection, pre-selection and transfer of urban waste: one in the Gherla–Dej area for the northern part of the county, one in the Turda–Câmpia Turzii area, and a third centre at Huedin for the localities from the western part of the county (mountainous, mainly rural area). From these three centres the waste remaining after the recovery of reusable and compostable materials would be transported into a fourth centre situated near Cluj-Napoca, the county's main producer of urban waste. For this areal system a study of feasibility[2] was elaborated in 2002–2004, which analyzed comparatively three possible variants for processing the county's urban waste: incineration, producing fuel from waste, and the mechanical-biological method. The objective of this study is to decrease the negative impact of waste on human settlements and the population. To attain this goal it tries to reduce the emission of pollutants to the environment, to respect the aesthetic criteria of waste disposal, to attain a negligible level of air, water, and soil pollution, and to reduce the impact of waste on the geological structure, landscape, and biodiversity.

For the incineration method, the waste is to be collected in special bio-containers in the first stage and transported to the processing facilities in the four areal recycling centres, where it is sorted. The compostable quantity is to be transported to the central composting

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[1] Cluj County Council, *Planul județean de gestionare a deşeurilor* (County Plan for Waste Management), ed. 1/2004.

[2] Cluj County Council, Feasibility study, *Gestiunea deşeurilor în județul Cluj* (Waste Management in Cluj County), 2004.

factory for biological waste with a capacity of 56,000 tonnes/year, where it is mixed with structure material, fragmented, and deposited in the soaking boxes for valorisation. The other waste materials, having been collected selectively at the source (paper, glass) are to be processed in the areal centres in pressing and ecological balloting installations. The aim of the thermal valorisation of waste is: to destroy the harmful organic substances from the residues; to sort inorganic substances and to revalorise them; to minimize the residues left after the burning process; and to valorise the energy contained in the waste. Thermal valorisation is to be realized in an incineration station with a capacity of approx. 130,000 tonnes/year. After incineration, the non-recyclable residue will be neutralized and deposited in a site for non-dangerous waste. As a sub-variant, the incineration of waste without previous biological treatment is suggested; thus the costs for the composting factory for biological waste can be economized. The total yearly maintenance costs of this system are approx. 18 million Euros, and the specific monthly costs after each inhabitant are estimated to 2.15 Euros. The yearly maintenance costs for the secondary variant are estimated to 18.5 million Euros, and the specific costs to 2.20 Euros.

The second variant of the study proposes a system producing fuel from waste. This system requires selective waste collection at the source, and the recovery of reusable materials. The rest of the waste quantity is to be sorted, pressed and ecologically packed, being then transported to the central station with a capacity of 185,500 tonnes/year. The method by which energy is obtained after drying the waste is known as the Herhof process. During this the waste is grinded, ferrous elements are recovered with the aid of magnets, the rests are placed into soaking boxes and recyclable organic substances are transformed in energy. The emitted energy is used for drying the waste. The ordinary fuel can be used in thermal power stations and in the cement industry. Non-incinerable waste, having been sorted, is stored on the site for non dangerous waste. The co-processing[1] of waste in cement factories, and the partial substitution of fossil fuels (coal, gas, crude oil) for energy containing waste, constitutes the exceedingly advantageous valorisation of urban waste.

The advantage as compared to incineration is that this process does not result in slag, dust, and mud, since these will be melted into the

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[1] Oana Dinu, "Implicarea industriei cimentului în gestionarea deşeurilor din România" (The Participation of the Cement Industry in Romanian Waste Management), *Salubritatea*, 3 (7) (2003).

resulting cement. Thus, an income estimated to 20 Euros per Stabilat tonne (Stabilat is the fuel product resulting from waste processing) is obtained. The yearly costs of maintenance are of 515.5 million Euros, and the specific monthly costs per inhabitant are of 1.85 Euros.

The third variant consists of the use of mechanical-biological installations with a capacity of approx. 130,000 tonnes/year. The collected waste is to be selected by sifting, passing it through sorting belts and other modern sorting equipments with the aim of obtaining some well-defined assortment categories. Inert residues are to be transported to and stored on the site for non dangerous waste. The compost piles are to be transported to the composting factory with a capacity of 56 thousand tonnes/year. The total yearly costs of maintenance for this investment are of 14.2 million Euros, and specific monthly costs are of 1.68 Euros/inhabitant.

The comparative costs according to components and works for the three study variants are presented in the table below:

Components/ works	**Waste incineration 1st variant (million Euros)**	**Producing fuel from waste 2nd variant (million Euros)**	**Mechanical-biological installations 3rd variant (million Euros)**
Collection	30.9	30.9	30.9
Recycling centres	4.1	4.1	4.1
Composting factory	10.58	–	10.58
Incineration station	89.5	–	–
Dried Stabilat station	–	47.5	–
Mechanical-biological station	–	–	32.67
Total	151.7	99.9	94.9

The data reveal that, financially speaking, the mechanical-biological system as a primary investment is the most advantageous. However, a long term global analysis emphasizes the advantages of the system producing fuel from waste due to the fact that all reusable materials from urban waste are highly valorised. Thus a smaller site is needed for storing inert residues, and the environment is better protected despite the initial higher costs.

The fourth study variant suggests the realization of an ecological urban waste disposal site in each county, which would function in the same system with the areal pre-collection and transport centres. After pre-selection the waste would be placed in a site organized in cells, in which waste could be placed for approximately a year. In order to optimize the storing capacity, the cells would have the form of some isolated basins with impervious bio- and geo-membranes having the role of protecting the environment, and to help the fermentation of organic substances. The biogas resulting from the fermentation process would be collected and used to produce thermal energy by direct burning, or electric energy. The moist substances from the site (levigated materials) would be collected through an impervious system, and conducted to the purification station in order to be treated. The investment costs for this procedure are estimated to approximately 40 million Euros, but, for a population of approximately 700,000 inhabitants, an area of 15–20 ha is needed.

To solve the problem of ecological urban waste management is an urgent necessity in order to realize optimal parameters for the protection of the environment and of public health, as well as to align with the standards of the EU countries with a “post-industrial” economic system.

Translated by Ágnes Korondi