

PRINCIPLES OF JUSTIFICATION OF REGIONAL PROGRAMMES OF MUNICIPAL SOLID WASTE TREATMENT

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Abstract

It is a scientific justification of the regional programme of treatment of the municipal solid waste (MSW) on the example of Odesa region which will promote increase of ecological safety of population, reduction of negative impact on the environment by improvement and modernization of the existing system of MSW treatment with final achievement of a "zero waste" condition due to transferring the maximum amount of waste in liquid secondary raw materials, alternative fuel and environmentally-friendly organomineral fertilizer. Such approach differs essentially from the existing developments of regional programmes of MSW treatment and has scientific and methodical and practical value.

Keywords: municipal solid waste, waste treatment, regional programme.

INTRODUCTION

In recent years the solution of the problem of MSW treatment has been becoming more and more difficult. The reasons are growth of MSW formation volumes, structural changes in MSW composition as well as changes in the system of regional and local government and in the legislative sphere of the waste treatment in Ukraine. As it is specified in the Law of Ukraine "About the Basic Principles (Strategy) of the State Environmental Policy of Ukraine by 2020", inefficient MSW treatment becomes more and more pressing environmental problem. In recent years the amount of MSW which is not prone to fast decomposition increases and demands significant areas for placement. The quantity of the overloaded dumps and landfill sites which do not meet standards of ecological safety grows in regions of Ukraine every year. According to "The National Strategy of Waste Management in Ukraine by 2030" [1] regional plans (programmes) of waste management are developed to assist realization of this Strategy no later than in two years after its approval. There has been a specific situation in each region which needs to be considered at justification of the regional programmes of the MSW treatment (RPT), but basic approaches to formation of these programmes will be similar in many ways.

"The Programme of Treatment of Municipal Solid Waste in Odesa Region for 2013-2017" (approved by the decision of regional council № 823-VI of 04.07.2013.) It was focused on "creation of conditions promoting full collection, transportation, utilization and burial of household waste and diminishment of their adverse effect on the natural environment and people's health as well as expansion and modernization of the operating capacities for MSW collection, processing and utilizing and creation of an effective control system in the sphere of waste treatment".

The current state analysis of MSW treatment system in Odesa region confirms that neither planned problems, nor prioritized focus on actions were not realized. Actually, this programme was focused on short-term measures, not for the realization of new technological schemes. It was never about implementation of "pilot" projects which could give the chance for practical tests and the choice of technologies for the mass implementation. Insufficiencies of this programme were considered in the design of the programme draft of MSW treatment in Odesa region for 2018-2022 (it was prepared by the USAID "Municipal Power Reform in Ukraine" Project), but this RPT of MSW was not approved by the decision of regional council. Consistent approach to development of RPT of MSW does not exist, but separate provisions concerning the formation of the principles of such programmes (with the example of Odesa region) are given by the authors of this article in their works.

The objective of the research is increase of ecological safety of population, reduction of negative impact on the environment by improvement and modernization of the existing MSW treatment system with

final achievement of a "zero waste" condition due to transferring the maximum amount of waste in liquid secondary raw materials, alternative fuel and environmentally-friendly organomineral fertilizer.

THEORETICAL PART

The problem of the effective MSW treatment remains one of the most essential environmental and social-economic problems of Ukrainian regions. Now the condition of MSW treatment in Ukrainian regions is at the unsatisfactory level. Unfortunately, the dominating way of MSW treatment in all regions is still their removal and burial on landfill sites that demands considerable land resources and exerts considerable impact on the environment. There are very few examples on prevention of MSW formation and utilisation of its resource-valuable components. In each region there has been a specific situation which needs to be considered during MSW treatment regional programmes justification. As a rule, the majority of these regional programmes are restricted by the determination of MSW formation volumes, inventory of landfill sites condition, calculations of necessary number of containers and technical means, justification of expediency installation of switchyards and new solid waste landfill constructions without definition of their location. Generally, regional programmes of MSW treatment were aimed to increase the quantity and the area of MSW landfill sites, but not to introduction of innovative approaches to create an effective treatment system as well as to financial resources distribution.

According to the goal of RPT, the solution of the following tasks is defined as follows: MSW classification and differentiation that will allow to choose for each separate MSW components stream the most effective in ecological and socio-economic aspects methods of processing, utilization and removal; inventory of the existing landfill sites ("polygons") and the forecast of MSW scales accumulation at the territory of separate regions; assessment of the scale of MSW generation in various parts of regions; realization the measures for elimination of unauthorized landfill sites and partial MSW utilization, which was saved up on these landfill sites; recultivation of overloaded and closed solid waste polygons; justification of creation a possibility of new (reserve) modern polygons for partial burial of the MSW which are not subject to processing or utilization; effective organization of collection system, transportation, processing and utilization of MSW components (including dangerous elements); justification of the principles of cluster strategy realization in the MSW treatment sphere in the regions` territory; justification of creation expediency of MSW processing and utilization centers with the best available technologies usage of secondary resources extraction and neutralization and utilization of ecologically dangerous components of MSW; increase efficiency in target usage of payments from population and governmental mechanisms of improvement of MSW treatment in the market economy conditions; increase of qualification of personnel who are involved in the sphere of MSW treatment; realization of set of measures for increasing level of ecological sensibleness and general population culture.

RPT with MSW development has to be based on existing legal framework (legislative documents in the treatment of MSW sphere, the relevant resolutions of the Ukrainian Cabinet of Ministers and orders of the Ministry of Ecology and Natural Resources of Ukraine, etc.).

RESULTS AND DISCUSSION

Considering that separate MSW collection has captured no more than 13% of Ukrainian settlements, namely separate collection is implemented for the purpose of only separate components subtraction (waste paper, glass, metal and plastic), it is possible to consider that almost all volume of created waste is placed in specially allotted places. It is noted that due to introduction of separate MSW collection, work of 21 waste sorting lines, 1 incineration plant and 3 waste incineration installations in Ukraine in 2014, it was utilised only 4,2% of MSW out of which 1,7% was burned, and the other was used as secondary raw materials. In 2014 in Ukraine there were collected 45 million m³ of MSW out of which 65% was removed to places of burial which officially accounted for 6 thousand with a total area of more than 9 thousand hectares. From 48 million m³ of the MSW formed in Ukraine in 2015 (without the data of the Autonomous Republic of the Crimea, the Luhansk region and Sevastopol), there were processed and utilized only 5,93% from which 2,73% were burned, and 3,2% got on procuring points of secondary raw materials and waste recycling plants [2].

The locations condition of MSW is not satisfactory: 16% of such constructions are overloaded, and 19% do not meet standards of ecological safety. Besides, there is a need of at least 576 polygons of MSW. In conditions when services in waste collection and removal 78% of the population is involved, there appear spontaneous landfill sites which were 24 thousand with a total area of 1,5 thousand hectares in 2014 [3].

For instance, waste treatment status in Odesa region is a subject of the annual regional report about the environmental condition, statistical reviews, special researches, ecological programmes, etc. The description of a condition of waste treatment, mainly limited to data about quantity and the area of landfill sites, volumes of the waste placed in specially allotted places (mostly industrial). However, such "standard" array of information about waste placement in specially allotted places does not allow to characterize fully ecological consequences of the existing situation with waste in Odesa region and determine the resource potential of such waste.

Carrying out the statistical information analysis about waste from different sources of information (as an example of Odesa region), it is possible to define a number of disadvantages which make complicate its practical use (first of all, it concerns high-quality content of the received results):

- 1) lack of explanation in reference books about the received statistic figures and the methodologies of their calculation (for instance, the number of the waste formed and placed in one year differs 1500 times; identity of concepts "placed waste in specially allotted places and objects" and "removed waste to specially allotted places and objects");

- 2) violation of integrity of information arrays (for example, in some areas of Odesa region there is no number of generated waste);

- 3) almost total absence of information about waste formation volumes.

For the solution of a task regarding division of Odesa region territory into districts on a set of the indicators describing placements of MSW on the basis of administrative regions association in characteristic groups, we used a method of the multidimensional statistical analysis - the cluster analysis. The usage of the cluster analysis for division the territory into districts according to a complex of indicators which are tied to certain areas is convenient and expedient [4]. Realization of an algorithm is executed with the use of application programmes package Statistica 7.0. A clustering method is k-averages. During processing mass of data was used a replacement of the absent data with average values. The set quantity of clusters is 5. At such set quantity of clusters the best results of association in groups take place with significant difference between the received clusters with indicators which are observed. For example, in the territory of Odesa region there are 5 clusters according to the following indicators: quantity of landfill sites; the area occupied for MSW; designed area of solid waste polygons, hectare; the design mass of MSW which will be placed on polygons, tonne; the share of the area which is occupied with places of waste disposal, %; quantity of landfill sites corresponding to 1 thousand inhabitants; dynamics of average areal change of one polygon for the separate period [5].

The obtained data of the cluster analysis can be a basis for justification of the principles of cluster strategy realization in the sphere of MSW treatment in the territory of Odesa`s administrative regions and also have to be used for determination of the necessary number of the waste sorting and waste-processing enterprises in the territory of the area.

Thus, the problem of the inefficient waste treatment which is typical for Ukrainian regions is relevant and formed MSW are removed in specially allotted places. On average, such objects occupy 0,03% of area space, but as it is defined they are characterized by positive dynamics of area and quantity changes. A current problem is the need in creation of the new places for waste disposal.

For assessment of the scale of MSW accumulation it is necessary to carry out inventory of their landfill sites. First of all, inventory of unauthorized landfill sites. At the same time, it is necessary to record features of a position, the sizes, possible sources, the dominating components and also existence of ecologically dangerous components of MSW landfill sites. For the overloaded and closed landfill sites it is expedient to offer recultivation activities.

As far as it will hardly be possible to refuse from complete polygon burial during a short period of time, it is expedient to prove a possibility to construct new (reserve) polygons with lines of garbage sorting, biochemical processing technologies (receiving biogas and ecologically safe organomineral fertilizer).

According to the Department of Ecology and Natural Resources of the Odesa Regional Public Administration there are 608 landfill sites on the territory of the area which occupies about 1300 hectares of lands [6]. Most of them are in an unsatisfactory condition and they are operated with violation of the nature protection legislation and sanitary and epidemiologic requirements of safety. For the purpose upgrading of the MSW treatment system it is offered to eliminate numerous of landfill sites and to construct four modern inter-districted MSW polygons within five clusters on the territory of Odesa region.

The placement of inter-districted polygons has to be based on DBN B.2.4-2-2005 "Polygons of MSW. Design bases." [7] which contains requirements about where "Polygons of MSW locate", where "polygons of MSW placements are allowed" and where "polygons of MSW placements are not allowed". In this regard, it is

expedient to analyse physiographic, engineering-geological, hydrogeological, technogenic and the socio-economic indexes defining possibilities of placement the modern MSW polygons on the territory of areas of certain Ukrainian regions.

MSW and their components classification is a necessary condition for a solution of the problem of management and treatment in Ukrainian regions and therefore we offered the newest approaches concerning the principles, applied classification aspects of MSW, their components and their treatment [8].

MSW include waste of the residential sector, waste of municipal infrastructure and municipal authorities. The general MSW stream consists of organic waste which easily decay; potential secondary resources (large-size waste and waste of container collection) and dangerous waste [9].

MSW generation and accumulation are the processes taking place within time therefore the methodology of MSW management and treatment is based on dynamic approach. The purposeful effect of the project implementation is minimization of MSW accumulation. It is implemented as a result of planning, organization, management and control of the material movement and connected informational and financial flows in the space-time coordinates during all the life cycle of MSW. The MSW components are considered as the differentiated streams of waste: 1) organic waste which decays easily (food waste, park and garden waste, waste of the markets etc.); 2) potential secondary material resources (SMR): large-sized household goods (old furniture, household appliances); waste of container collection (various containers and packaging, waste paper, textiles, metals, glass, leather, rubber etc.); inert mineral large-sized waste (construction debris) 3) dangerous waste (medical waste, mercury lamps, electrical current sources, accumulators).

The principle of MSW flows differentiation which is the basis of the Project of MSW treatment in the region is offered to be realized as follows:

- at the initial stage of MSW life cycle the flow of organic waste which decays easily is separated from the general flow of waste at the time of their generation; the flow is structured depending on the place of generation (type of a house, an object of city infrastructure)

- the flow of potential secondary material resources which is generated as a result of urban population activity and economic activity of infrastructure facilities is divided into components: a) old furniture and household appliances are sent to the specialized organizations for dismantling with the subsequent utilization; b) containers and packaging, waste paper, textiles, metals, glass, leather, rubber are gathered in the mobile containers, marked for each type of SMR and are taken out for further sorting and processing; c) the inert mineral large-sized waste which is formed during carrying out construction and refurbishing works in households and city coordinated objects have to be processed and used in planning works;

- the flow of dangerous waste which is formed in households and city infrastructure facilities is allocated from the general MSW flow by means of the organization of address collection of components of the flow.

The managerial principles of MSW flows are developed for Odesa region: the principle of alternative compulsion of economic entities (the organic flow decays easily), the principle of economic feasibility in a chain "the producer of waste" - "the sorter of waste" - " a processor of SMR" (the flow of potential secondary material resources) and the principle of material interest of the parties (the flow of inert mineral large-size waste); principle of conscious safety (the flow of dangerous waste).

The solution of the problem with municipal solid waste treatment within Odesa region is carried out on the basis of an integrated approach.

Creation of environmental protection and safety conditions of local population activity are provided with the help of the system of the organizational and economic actions which are based on the principles of sustainable development and consider specifics of the region development.

Considering significant financial expenses, the first step to differentiate MSW flows can be the obligatory separation of organic waste which can decay easily during the time of its generation as well as dangerous MSW component.

Organic waste which can decay easily is the secondary raw materials for receiving biogas and organomineral fertiliser and therefore there is a need of planning biochemical processing of environmentally-friendly organic waste flow during new polygons construction in which it will be possible to receive environmentally-friendly organomineral fertilizer and alternative energy source.

It is recommended to install four containers on the container platform. The first container is with the label "Food and vegetative (park and garden) waste" for collection environmentally-friendly organic components of waste which can decay easily, the second one is with the label "Dangerous waste" for collection of medical waste, mercury lamps, sources of electric current, accumulators, etc., the third one is with the label

"Secondary Raw Materials" which is intended for collection resource of MSW valuable components which will be sent to the waste sorting enterprise, the fourth one is with the label "Unsorted waste" which content needs to be sorted at a recycling point.

It is necessary to add to the organic waste flow similar waste from the food industry, vegetable storehouses, catering establishment, the markets, the discarded products of supermarkets and so forth for mutual processing. The seasonal formation of fallen leaves and trees and bushes cut (the second component of this MSW flow) causes the need in organization the centralized collection and relocation of this substance for composting or anaerobic fermentation on specially equipped platforms or in the special equipment (methane tank). An alternative version of the treatment of this type of organic waste in the private sector houses with backyards can serve mutual composting with food waste.

Construction of debris utilization can be provided with the use of this type of waste in road construction or as filler in concrete production.

Dangerous waste neutralizations has to be carried out with industrial means.

Realization of MSW treatment system provides creation of the municipal center of the secondary material resources (SMR) recycling on the modular and block principle basis. It is expedient to include in the structure of the center the coordinating administrative group, SMR structure-store and transport division. The main structure element of the recycling center has to become a recycling point which is located on the place of one of the block yard container platforms and consists of 5 modules: 1) the module of the separated organic waste which can decay easily; 2) the module of sorting of the stabilized potential SMR; 3) the module performing functions of collection point for secondary raw materials and taking in for money separate MSW flow fractions which is sorted by the population; 4) the module of large-size waste taking in and dismantling; 5) the module of dangerous household waste fraction collection [8].

It is necessary to provide logistic service of points by small mobile economic vehicles. At offered scheme application of collection it is necessary to provide centralized transportation of collected waste fractions in one type of container and in separate vehicles. As long as the mass of separately collected waste in a recycling point is accumulated, it is transported to the warehouses of the recycling city centres or directly to the waste sorting / waste-processing enterprises and for industrial neutralization.

It is possible to change the situation in the MSW treatment sphere fundamentally by means of cluster approach. The principle of differentiation of MSW flows which is the basis for the concept of MSW management and treatment of city agglomerations [10] is the key within forming cluster structure of MSW treatment. The cluster in the MSW treatment sphere is multispectral and therefore there have to be objects of the following types: 1) "core" are objects around which the cluster groups, they carry out a primary activity and turn out end products; 2) "complementary" are the objects which provide directly functioning of "core" objects; 3) "serving" are objects which existence is obligatory but their activity is not directly connected with "core" objects functioning; 4) "secondary" are the objects which existence is desirable but is not obligatory for other cluster objects functioning.

We developed cluster structure in the MSW treatment sphere for Odesa region [8, 11].

To the first level belongs the higher educational institutions on the basis of which research works take place, develop technological and logistic chains in the MSW treatment sphere and their components, estimate efficiency of incarnate developments, for instance, the Odesa State Environmental University, Institute of Problems of the Market and Economical and Ecological Researches, etc.

The second level of MSW treatment cluster is provided by recycling points and at recycling city centre, the waste sorting enterprises rendering various services in waste collection, transportation, sorting, that is turning them into condition of the secondary material resources (SMR) and dangerous waste separation. The enterprises which use the received SMR as raw materials for target production and the enterprises at which there is a destruction / neutralisation of a dangerous flow of the waste which is extracted from MSW refer to this level of cluster.

The material flows created at this level of a cluster are involved in the goods production sphere as raw materials and energy sources which reduces significantly anthropogenic pressure on the environment and provides economy of the substantiated work and natural resources. Conditions of economic interests realisation of a cluster participants which form its second level are to have available equipment and technologies for collection, transportation and waste processing, qualified personnel, innovative developments as well as the invariance of market demands for SMR and production made from waste. The second level participants of a cluster in Odesa are LLC "Soyuz", the RC OF "Odeskomuntrans", LLC "Ekorenesans", "Green-port" and others.

The third level of MSW treatment cluster is infrastructure which is formed by the organisations and institutions providing activity of subjects of managing of the first and the second cluster levels with the administrative, informational, personnel, financial and other resources which are necessary for their functioning, trade enterprises which sell the produced SMR and end products as well as mass media which are necessary in the course of citizens ecological consciousness formation. Local administrations (with housing and communal services), transport institutions with specialised vehicles, the trade enterprises, institutions which carry out preparation and retraining of personnel of the corresponding qualification (the Odesa State Environmental University and the Center of Postdegree Formation of the Odesa State Environmental University) and city media have to be participants of this cluster level.

Thus, RPT with MSW need to be realised in 4 directions: 1) the embodiment of MSW treatment system in the city (separation of the organic easily decomposed fraction and dangerous waste, recycling points and centers creation, etc.); 2) work on the polygon (waste sorting enterprise construction, creation of biochemical processing and then composting, receiving biogas) 3) logistic of service development (transition to small-sized garbage trucks, different cars for the MSW separate components or cars with separate sections without waste suppression); 4) educational work with the population, training, advertising, etc.

CONCLUSION

The mass of the saved-up MSW in landfill sites and polygons of Odesa region, the current state of MSW treatment system threatens the status of the environment and the citizens` health. Justification of the MSW treatment regional programme (with the example of Odesa region) will promote increase in ecological safety of population, reduction of negative impact on the environment by improvement and modernisation of the existing MSW treatment system with final achievement of a "zero waste" condition due to transfer of the maximum amount of waste in liquid secondary raw materials, alternative fuel and environmentally-friendly organomineral fertiliser. The implementation of conceptual and theoretical basis of formation of the optimized MSW treatment system will promote the main achievement of sustainable development of the regions.

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