

**Development of Solid Municipal Waste
Treatment System within Circular
Economy Framework**

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Abstract

The scarcity of resources and the unlimited needs of society, which are the basis of economic processes, have led to the fact that in order to prevent a total shortage and irreversible environmental damage, it is necessary to review and change linear business processes and production models to cyclic ones under the control and at the initiative of the state. The result is in minimizing non-recyclable waste production and consumption, which can be achieved by the development of technologies reducing resource intensity of production, and by implementation of measures aimed at extending economic active life of goods through repair and joint consumption. The authors present the key circular economy technologies allowing achieving a set of sustainable development goals. The main results obtained by the authors in the study include assessment of trends in the development of strategies of solid waste processing conducted under supervision and funding of the state.

Key words: Circular Economy, Solid Municipal Waste, Recycling, Business Social Responsibility, Treatment Strategies.

At present, the problem of processing and disposal of municipal solid waste has grown into one of the most important problems of modern civilization, since the structure of waste sent to landfills has changed significantly over the past decades, while most of the waste is still not sorted. The attractiveness of landfill always varies depending on the factors of use of municipal solid waste; however, the price of landfill has a strong effect on the attractiveness of landfills use by businesses and individuals. Since only a certain part goes to disposal, which must meet certain requirements and rules, it is logical to assume that not all waste is subject to disposal.

The system of production and waste treatment is the most expensive, as well as legally and socially demanding. The reason is that in addition to providing benefits for entrepreneurs for collecting, sorting and processing their waste, it is necessary to achieve technological safety for society and nature, as well as to create and maintain a specific infrastructure that ensures the implementation of all these processes. In Russia, at the national level, state programs and projects are being implemented aimed at introducing circular economy technologies. One of the latest examples is the adoption of the federal project "Circular Economy", which is part of the national project "Ecology" and provides a

systematic, large-scale, consistent approach to the introduction of legislative, infrastructural, technological methods for processing production and waste treatment.

Modern strategies of solid waste processing are focused on the availability of subsidies and budget investments from the state; coordination of actions for liberalization or vice versa, toughening of requirements for sorting, processing and disposal of unprocessed "tails" by state structures and monopolies lobbying the interests of their industries.

Banning the disposal of food waste should be an important decision, which requires the development of related types and branches of economic activity. This measure is related to the transfer of part of food waste as raw materials for animals, including domestic ones; with the development of food-sharing practices. This contributes not only to solving the issue of processing or recycling a number of expired food products, but also develops social responsibility of entrepreneurs to the low-income population. When non-profit organizations and digital platforms act as an intermediary, they ensure delivery of such goods to the interested consumer on free of charge basis or for a minimum payment. All of the above confirms the demand for circular economy technologies in Russia, but in conformity with the

specific model, all stakeholders have to develop individual approach to solving the issues.

- From the *state* and *local government*'s perspective, circular economy technologies should be clearly identified and their introduction results should be precisely specified. Furthermore, subsequent control over the implementation and obtaining the planned effects (budget investments efficiency) is to be conducted.
- From *population* perspective, it is necessary to develop a certain level of responsibility, consumption culture, processing and recycling of solid municipal waste.
- From the perspective of *entrepreneurs* or *businesses* involved in economic activity, its maintenance by industrial complex or new technical services and innovations, a systematic approach should be introduced to technologies and methods implemented, as well as responsible investment practices, corporate governance, quality and safety control.

The Circular economy concept as opposed to the Linear Economy is aimed at extending economic and consumer life of goods as well as of resources. The circular economy revises the understanding of production or consumer waste, demand for

technologies allowing obtaining the expected effects in saving resources and minimizing non-recyclable waste and used goods. It should be clarified that cyclical economy can be applied for such types of activities where resources and results are material, except for developing consumer behavior models that correspond to goals and tools of sustainable development.

The trends accompanying implementation of circular economy technologies include: minimizing CO2 emissions, introducing business models with most energy-intensive production and maximum waste recycling. Using the example of solid waste treatment, the trend is clearly demonstrated by production of recyclable goods for further use.

There is an increase in the processing waste cycles from primary production as raw materials for the next production cycle. The minimization of the so-called "tails" takes place as they are already subject to disposal due to inability of the existing technology to include them into next processing cycle. There are three ways to achieve these results:

- production cycle is completely closed in a single chain of processing materials and restoring goods, their repairing and modernization with control over the allowable loss as newly

obtained materials after processing, clarify that the number of recycling rounds is limited;

- production cycle is maximally narrowed in conformity with current technological and innovative level of development by reducing the share of materials used. Digital technologies and digital transformation of business processes in this respect are an important condition for building a cyclic rather than a linear production model;
- slowing down the production cycle in terms of maximum possible time extension and an increase in the consumers of goods boost the demand for repair services and all the main types of sharing economy.

This work has revealed several factors and strategies that are responsible solid municipal waste treatment using the required technologies in circular economy.

Simultaneous shift from linear to cyclical business model of other stakeholders in the solid waste treatment is a condition for its successful introduction and functioning. First of all, availability of landfills is of crucial importance, moreover, it is meaningful to create conditions for affordable and effective use of modern recycling technologies, as well as extending economic active life of

goods through repair and joint consumption. The factor of transportation costs is a component ensuring investment attractiveness; therefore, state support should be directed in general to stimulating affordable price of transportation to landfills, waste disposal, supporting other participants of the full cycle production chain, maximum processing and infrastructure for safe disposal of non-recyclable "tails". To this end, attractiveness of such activities for private investors can considerably be supported by state budget investments and subsidies, financial control and audit.

An important role is played by a number of landfills located at a close distance: the more waste is transported to the landfill, the faster the land resources that are used for disposal are depleted and the filling rate is the higher, the more waste goes to the landfill. But it is worth considering the fact that over a certain period of time, some of the waste will go through the entire recycling cycle, which means that some area will be released that can be reused for disposal, while there is a relationship showing that the more waste there is, the more part of the land resources can be reused. Transportation costs should also be taken into account, which vary depending on the number of landfills at a close distance, while the price of waste disposal is related to the cost of the landfill complex, since the more expensive the equipment is, the more difficult it is to

maintain. It requires a highly qualified personnel which means that processing will be more expensive.

When the number of enterprises in the field of solid municipal waste introduces changes, the total volume of waste that goes through the recycling to obtain secondary raw materials also changes and the shift is proportional to the number of enterprises. However, it is necessary to take into account the costs of processing, which are inversely proportional to the amount of waste processed. Considering the factors that affect the costs associated with waste processing, we can include four of them which are inversely proportional in particular: the *amount of waste recycled*, the *recycling fee*, *incentives for the development of the market for secondary resources* and the *amount of sorted waste*. Another parameter is directly proportional to the barriers to the *development of the secondary resource market*.

The main strategies which can be used to deal with solid waste treatment are of different efficiency level, which shows the performance of each factor used. The *strategy of minimum control* assumes the absence of any further actions to attract business and residents to implementing methods of proper disposal of municipal waste and lack of state initiative in this area. Business and residents can throw garbage anywhere, which leads to the formation of

illegal dumps, while solid waste landfills are located at a great distance. The strategy of *government incentive* involves the work with business and population to stimulate separate collection and disposal of solid waste: various tax promotional activities are carried out which leads to a high degree of attractiveness of recycling, as well as separate collection of waste by companies and individuals. The strategy of *obtaining profit from recycling* and secondary use of disposable waste consists in such a development when enterprises are interested in recycling waste, and therefore provide convenient access to waste disposal sites, and also do not overcharge for the processing of incoming waste. The *unified strategy* applicable in circular economy presumes that all possible measures will be taken to develop the sphere of waste processing and disposal under the state initiative.

Thus, it can be seen that the most effective course of action is the unified strategy, since when conducting various campaigns that encourage businesses and population to sort waste, extend economic active life of goods through repair and joint consumption, the attractiveness of recycling increases; price containment measures also play an important role, since when choosing this strategy, there will be a noticeable increase in the volume of recycled waste and reduction in the amount of waste sent to illegal

landfills. In authors' opinion, the least effective tactic is the minimum state control, in which illegal landfills will not be reduced and will receive the same amount of waste as before.

The sharing economy is an important component of the circular economy, as it helps to extend the economic life of any product for which the secondary consumption market, the rental of goods are available. The main condition for successful development of the key sectors of the sharing economy is the transparency of the terms of the transaction and responsibility and trust between the participants in the lease or secondary sale. The development of the sharing economy also has a positive effect on the reduction of solid municipal waste and on the increase in options for processing goods that have lost their consumer properties. The system of maintenance and repair that prolongs the operation of many goods also contributes to the rationalization of the production of such new goods in the context of a policy of saving resources and minimizing energy and resource intensity.

All of these trends in the cyclical nature of business processes and consumer decisions directly or indirectly reduce the current volume of municipal waste production. The development of technologies for sorting, processing and safe disposal of "tails" that cannot be processed is one of the priorities for the development of

the national IT-sphere. The reason is the necessity ensuring not only the availability of such technologies for municipalities, entrepreneurs, government agencies, households (at a price, in terms of quantity, performance, maintenance, repair, etc.), but also the safety of their operation. It is necessary to review and change linear business processes and production models to cyclic ones in the area of solid waste treatment under the control and at the initiative of the state.

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