

The improvement of municipal solid waste management in Russia based on the criteria of a circular economy

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Abstract—In the paper, the authors propose to consider the problem of MSW management that is relevant for Russia from the standpoint of a circular economy as a continuation of the ideas proposed in the concept of sustainable development and the ecological economy. The authors formulate the criteria for a circular economy applicable in the system of MSW management. The authors also propose a methodology for rating technologies for processing MSW under the criteria of a circular economy, which can make the process of technology selection more objective, both for state and private investors. It can also serve as an argument to justify decisions to reduce the production of products, the processing technology of which does not meet the criteria of the circular economy.

Keywords—MSW management; circular economy; ranking of the technologies.

I. INTRODUCTION

The decree of the President of the Russian Federation “On the national goals and strategic objectives of the development of the Russian Federation for the period up to 2024” contains twelve priority directions of the country's strategic development, and one of them is the environment. The main task in this area is to “create an integrated system for dealing with municipal solid waste (MSW), including the elimination of landfills and the recultivation of the territories of its location, the creation of conditions for the recycling of all the waste, that can not be disposed on the waste landfill”. The problem of MSW management is as relevant as ever – in 2016, 60 million tons of MSW were generated in Russia, 91% came to landfills. While in some European countries (Switzerland, Sweden, Belgium), this indicator tends to zero.

In addition to the apparent problem of environmental pollution by waste decomposition products on landfills, including methane, as well as the removal of land from economic use (landfills occupy 4 million hectares, and this area is increasing annually by 300–400 thousand hectares), this situation indicates extremely inefficient use of natural resources – about 70% of generated MSW can be reused. This rash attitude towards waste brings humanity closer to a resource catastrophe, which in 1972 in the “Limits to Growth” report was discussed by D. Meadows and colleagues [1].

The attitude to waste in Russia that has existed for decades mainly fits into the logic of a traditional, linear economy based on the principle of extracting natural

resources, making the goods and disposing of waste in landfills (the principle of “take, make, waste”). Today, many companies and countries are introducing alternative business models based on a circular economy. The circular economy model emerged in the 2000s as a logical continuation of the sustainable development concept [2], ecological economics [3], works of Walter Stahel [4,5,6], the concepts of Zero Waste [7,8] and Cradle-to-Cradle [9], the scientific basis of Industrial Ecology [10,11].

The circular economy assumes that the manufactured goods must be in circulation for as long as possible through such tools as refurbishment, remanufacturing, rental, maintenance, reuse, and at the end of the cycle, raw materials can be recycled. The circulation of biological and technogenic materials in closed cycles minimizes the consumption of non-renewable natural resources and the flow of waste into the environment. Also, special attention in the framework of the circular economy is paid to the sharing of goods (sharing economy) [12].

The circular economy model is a 3R model (Reduce, Reuse and Recycle), which means reducing the environmental impact and consumption of non-renewable resources, re-using resources, recycling waste.

We can formulate the criteria for a circular economy as follows:

- use of waste as raw material for the production of new goods;
- the design of the components in the way that they can be processed with minimal energy and without loss of quality;
- use of renewable energy sources;
- it is more efficient to reuse goods, carry out their maintenance and restoration, rather than recycle them and return them to the level of the component manufacturer;
- the need for a complex assessment, taking into account economic, environmental, social factors.

In waste management, we can express the application of a circular economy model in the implementation of the following processes based on its criteria:

- 1) maintenance of goods;

- 2) reuse of goods;
- 3) sharing;
- 4) refurbishment, remanufacturing;
- 5) recycling (which can be upcycling - the transformation of materials and waste into new materials of higher quality; functional recycling - recovery of materials for the original purpose or other purposes, except for energy; and down recycling - the transformation of materials and waste into new materials of lower quality).

These processes can form the following business models that meet the canons of a circular economy: recovery and processing; increased product life cycle; exchange and sharing, product as a service, etc. These business models can be used both individually and in combination.

Such services as Delimobil (car sharing), taxi Yandex and Uber, Airbnb, Avito, Yula (Russian platforms for selling goods); sale of refurbished cell phones and home appliances; processing and production of goods from recycled materials (plastic, paper, glass, textiles); providing services instead of selling goods (Philips Pay Per Lux project, renting office equipment, coffee machines), etc. – all of them are successful business models, mainly emerged in the last 10 years, are based on the criteria of a circular economy and reduce the amount of waste.

Thus, in many aspects, the problem of waste can be solved based on the criteria of a circular economy, and authors believe that this is the most effective way since it allows:

1. To reduce the environmental impact during the production of various goods/services, and during the disposal and incineration of waste.
2. To reduce the consumption of non-renewable resources owing to the longer use of goods in the economic turnover and due to the processing of the generated waste.
3. To achieve the above effects using high-yield, innovative business models.

In the same way, the problem of waste management is discussed in the global community [13,14,15,16].

Of course, the legislative measures adopted in Russia over the past few years have made significant changes in the sphere of MSW management and contributed to the transformation of this sphere under the criteria of the circular economy.

Several important regulatory and economic measures have been implemented, such as territorial waste management schemes and local waste management programs; institute of regional operators (several special organizations responsible for MSW management in each region); extended responsibility of manufacturers and importers, etc.

However, specific problems remained unresolved. Thus, by law, municipal solid waste is defined as "... waste, generated in residential premises in the process of consumption by individuals, as well as goods that have lost

their consumer properties in the process of their use by individuals in residential premises in order to meet personal and domestic needs." That means, the category of MSW includes both goods that have lost their consumer properties for specific consumers, or have ceased to meet their needs (failed, obsolete, in need of recovery, etc.), as well as waste.

At the same time, MSW management is reduced to the utilization, which is "the use of waste for the production of goods (products), the performance of works, and the provision of services."

Thus, initially the waste management in Russia does not include the processes of reuse, sharing, maintenance, recovery, but the maximum profitability and resource saving with a minimum impact on the environment are in these processes. Also, this means that the tools that stimulate these types of activities are not provided by law.

Another problem is the lack of classification of MSW under the criteria of a circular economy. So, there are types of MSW, the processing of which is established (there are technologies, market, infrastructure) and waste, processing of which is either costly or technically impossible. An example of this is a plastic waste. Bottles for drinks, blisters, packages made of PET and high-density polyethylene can be processed quite effectively. As for plastic waste produced from low-density polyethylene, polypropylene, polystyrene – it is more difficult to recycle. A waste, which is based on polyamide, polycarbonate is likely to be disposed on the landfill or go to the incineration plant.

The existing classification of MSW does not take this fact into account. Similarly, the environmental utilization fee within the framework of the expanded responsibility of manufacturers and importers is not differentiated depending on the degree of processability of the waste.

Another problem is that the existing MSW processing plants face low workload, which directly affects the performance indicators of their work. The legislator has chosen in favor of developing a network of enterprises collecting MSW, while many countries have taken the path of increasing public involvement in the process of sorting waste.

II. METHODS

To improve the MSW management in Russia and increase the efficiency of funding the recycling activities, the authors propose to rank the BAT for the processing of MSW under the criteria of a circular economy.

Authors propose to rank BAT for the processing of MSW using both traditional indicators of economic efficiency (total net present value, profitability index, discounted payback period, etc.) and additional indicators based on the criteria of the circular economy.

In the process of selection, the additional indicators serve as informal assessment criteria which set limitation terms when rating the BAT.

III. RESULTS

The matrix of BAT ranking is presented in Table 1. During the ranking of BAT, each indicator should be standardized. The procedure consists of the following: we

divide every indicator by the best indicator, and then the matrix of standardized indicators (K_{ij}) is built.

In order to define the significance of indicators, we can use a method of expert evaluation. The significance of each indicator is valued in points, e.g., on a three-point scale (3 is for the most significant indicator, 1 is for the least significant indicator).

TABLE I. MATRIX OF BAT RANKING

Indicator	Standardized indicator		α	Ranking estimation of each indicator	
	BAT 1	BAT n		BAT 1	BAT n
1.Net present value (NPV)	K_{NPV1}	K_{NPVn}		P_{NPV1}	P_{NPVn}
2.Profitability Index (PI, %)	K_{PI1}	K_{PIn}		P_{PI1}	P_{PIn}
3.Discouted payback period (DPP)	K_{DPP1}	K_{DPPn}		P_{DPP1}	P_{DPPn}
4. The percentage of useful extraction of raw materials (resource efficiency, %)	K_{RE1}	K_{REn}		P_{RE1}	P_{REn}
5. The decrease in carbon footprint (carbon efficiency, %)	K_{CE1}	K_{CEn}		P_{CE1}	P_{CEn}
Resulting bottom line					

After that the ranking estimation of indicators is calculated by the formula:

$$P_{ij} = \sqrt{\alpha_i(1 - K_{ij})^2} \quad (1)$$

α_i - weighting point, defined by experts

K_{ij} – standardized indicator.

Then we can rank BAT according to the criteria of a circular economy. The most attractive BAT is the technology with the minimum sum of points ($\sum P_{ij}$) according to the ranking procedure.

IV. CONCLUSION

In the paper, authors have analyzed the MSW management system in Russia and proposed the way it can be improved based on the circular economy criteria. One of the authors' suggestions is the ranking procedure for the BAT for the processing of MSW, which includes both traditional indicators of economic efficiency (total net present value, profitability index, discounted payback period etc.) and additional indicators based on the criteria of the circular economy. The suggested ranking of the technologies for the processing of MSW makes the decision-making process for the government and private investors more objective, without excluding the priority of commercial

effectiveness, but involving on equal terms the criteria of a circular economy. This ranking procedure may be used for example in the distribution of funding in local waste management programs.

Also for the BAT in MSW processing which hardly meets the criteria of the circular economy it may be considered to limit the circulation of products leading to the formation of such kind of waste.

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