

# Transition to a circular economy model as an alternative option of solving the problem of solid waste utilization

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**Abstract.** Socio-ecological problems are relevant, both at the global and at the national and regional levels. In 2020, much attention is paid to ecology. Due to environmental problems, it is planned to switch from a standard economic linear model to a circular economy. The authors considered the theoretical side of the circular economy, as well as the principles of such a model. The article discusses the existing scheme for the disposal of municipal solid waste, and also shows a new scheme for the disposal of municipal solid waste in the Arkhangelsk region as part of the EcoTechnoPark Shiyes project. The article discusses both the positive and negative aspects of this project. The authors conducted a sociological survey among the population of the Russian Federation, where it was proposed to evaluate the attitude to the EcoTechnoPark Shiyes project and the possibility of organizing separate waste collection. At the end of the article, possible solutions to the problem of recycling solid waste are suggested, options for adaptation and motivation of the population to solve this problem are considered.

## 1 Introduction

Recycling of waste and garbage in the Russian Federation is a serious problem for the state and the entire population. Most of the household waste is stored in landfills in thousands of tons and only five percent of the garbage, according to statistics, is recycled for further disposal. To protect the environment, all landfills and dumps must at least meet certain ecological requirements, such as sufficient distance from settlements in order to prevent harm to residents and wildlife.

World leaders in the waste processing industry, such as Germany and Korea, use solid municipal waste briquetting technology with their further placement at landfills. These countries, using this method, comply with all the requirements of the technology, which allows to provide the safe disposal of waste in the so-called "dry" landfills, excluding the appearance and formation of leachate. It is believed that a method such as briquetting helps get rid of open landfills. If you use the technology correctly, then packing briquettes eliminates the decomposition of garbage, and also makes it possible to transport at any time and to any point [1,2].

## 2 Materials and research methods

The theoretical basis of the study is the work of domestic and foreign scientists dedicated to the problems of sustainable socio-economic development, the theory of external (environmental and social) effects, the concept of natural-industrial cycles [3-7].

The empirical and informational basis of the study, in addition to special literary sources, was a sociological survey of the population of the Russian Federation, conducted by the method of online research. Research methods used: economic-statistical, comparative-analytical, system analysis.

## 3 Utilization of municipal solid waste in Russia: problems and prospects

Residents of the Russian Federation annually produce about sixty million tons of household waste. The so-called "garbage reform" is currently underway aimed to solve the problems of recycling a huge amount of waste in Russia. There are several ways of recycling and utilization in the country, such as composting, incineration and conversion.

Most cities have a simple solid waste utilization scheme. According to this scheme, garbage is first collected, then taken to the landfill, at the last stage it is disposed or buried. The advantages of this method are minimal costs and convenience, but the decomposition of such garbage in warehouses is harmful to the environment and leads to an annual increase of the size of landfills. Disposal of solid municipal waste in this way leads to environmental pollution, which negatively affects the state of air, water, food of plant origin and, thus, is a threat to public health.

One of the ways to solve the problem in many countries is the use of briquetting method. In the Russian Federation, briquetting technology has already begun to be used; the greatest success in applying this method has

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been achieved in St. Petersburg [8]. The main advantage of briquetting is getting rid of open landfills.

In the Russian Federation it was decided to create an EcoTechnoPark Shiyes solid waste landfill using foreign experience. The motivating solution for creating such a landfill was the problem of disposal of municipal solid waste in Moscow, where a fifth of the country's garbage is produced. After the analysis of the territory of the Moscow region, it was revealed that in the region there are no land plots that would meet the requirements for the placement of such sites., So the Arkhangelsk region specifically the Shiyes railway station was chosen to place the landfill.

Shiyes railway station was chosen for several reasons. This station has the minimum necessary infrastructure, such as electricity or sidings. Shiyes is also suitable because of its low population density, but this does not exclude the possibility of harming residents living in neighboring villages located near the Shiyes station. Such villages include: Madmas, Yarensk, Urdoma [9]

Another argument for the location of the landfill in the Arkhangelsk region was the climatic conditions of the northern region, since the environmental impact due to the low average annual temperature is minimal, because the low temperature mode slows down the biological processes of waste decomposition. Specialists working with the Shiyes project are aimed at extracting organic components from solid household waste in order to avoid the process of decay.

At the heart of this ecotechnopark scheme there is a new for Russia technology that is offered by Flexus company. This technology is aimed at the deep pressing of waste and solid household waste components that have previously been sorted. As a result, secondary material resources should appear. The technology involves the removal of this garbage within a month, since no film can save from the process of decay and gas emissions for several years.

Environmental experts from Sweden who are familiar with this technology claim that it is impossible to fully utilize organic waste. The process of decay can lead to the release of landfill gas. Countries that use this method do not store garbage for more than a month, which helps to avoid possible negative consequences. However, when making this decision, serious points were not taken into account, one of which is that in order to preserve the environment it is necessary to carry out monitoring, and it should be carried out applying specific equipment using the method of micro-vortex pulsations. The problem is complicated, since there are only a few instances of such equipment in Russia. In addition, to conduct monitoring with this equipment, competent specialists are required.

Secondly, the territory where they intend to create the Shiyes training ground has its own soil characteristics associated with a high level of groundwater. This creates a risk of penetration of waste and groundwater pollution, which will not save even the waterproofing coatings and screens made of geomembrane and bentonite mats declared by the developers of the project [9]. Nearly two and a half million tons of waste are going to be stored at

the landfill, so non-compliance with technologies and the slightest departure from Western developments can cause irreparable harm to both the environment and the population of not only the region, but also the surrounding regions, and for many years to come. This is even more dangerous, since the landfill will be located in the Far North with a particularly vulnerable ecosystem [10,11,12].

#### **4 Transition to a circular economy and closed chains as an alternative to the solid waste briquetting method**

The relevance of secondary raw materials, the latest heat treatment technologies that turn waste into valuable resources and energy are an alternative option to the proposed scheme for waste disposal in the Arkhangelsk region [13-15].

The possibility of generating energy from waste belongs to the circular economy. This concept is based on 4R principles that provide circular value chains. These principles include the reuse, recovery, processing and reduction of resource consumption in the production of goods. In the process of transition to a circular economy natural resources circulate in biological and technical areas. Reuse of waste involves reverse logistics, which allows returning products back to recycling [16-17].

Solving the problem of municipal solid waste can be provided by using the circular economy. Priorities in this area are products such as plastic, critical raw materials, biomass and bio-products. The circular economy also allows the introduction of industrial symbiosis. This process is characterized by the cooperation of two or more manufacturing enterprises, when as a result the waste of one company becomes the raw material of another company. Symbiosis is possible in the sectors of woodworking, heating, building materials.

Using a circular economy will optimize business entities where the main problem is the irrational methods of using and using resources. In order to effectively use the available capacity, it is necessary to ensure a stable production cycle.

The Russian Federation has all the possibilities for applying this direction: the existence of renewable energy sources, such as hydroelectric power plants in large quantities; almost fifty percent of the country's territory is forest area, so there exists a possibility of technology development and the desire to switch to joint consumption [18].

The introduction of such a system implies, first of all, a systematic approach, which in this case involves the introduction of mandatory separate collection of municipal solid waste. Therefore, complete monitoring is important as well as accounting for harmful greenhouse gas emissions.

Transition to a circular economy, first of all, allows to reduce the negative impact on the environment, which is an important problem for the whole world. A reduction in the use of resources in production will result

clean and safe environment, as well as reduction of production costs.

Switching to a circular economy requires the popularization of such a lifestyle among the population. The experience and situation at Shiyes Station confirms the desire of residents to implement such technologies. Forming a circular economy provides not only an alternative to landfills and to the problem that arose in the Arkhangelsk region, but also create an tool for sustainable development in Russia [19,20].

Analyzing the situation that has developed in the Arkhangelsk region, it can be argued that residents are concerned about the state of the environment of their region and are ready to do everything possible to preserve and protect the nature. In order to identify the attitude of the population towards a possible transition to a circular economy model, which includes, first of all, garbage sorting, a sociological survey was conducted among citizens of the Russian Federation. The survey involved 560 respondents. It was necessary to answer questions about readiness for the transition to separate collection of garbage, as well as to identify motivational aspects. The survey proposed evaluating the ecological situation in the city and awareness of the circular economy.

It should be noted that 77.9% of respondents have not heard about the circular economy, which confirms the lack of information of the population on this issue. However, 96.7% of respondents are ready to sort the garbage and consider it right. 83.6% of the survey participants noted that the material component would be the motivation for starting garbage sorting for them. Despite the fact that many respondents are concerned about the environmental component, namely 55.7%, however, survey participants noted that measures such as privileges or discounts for participants who joined separate waste collection, or a bonus system with the possibility of exchanging such bonuses for material needs motivate respondents. The percentage of answers on this question was 19.9% and 25.4%, respectively. The survey also asked the question of assessing attitudes towards the EcoTechnoPark Shiyes project, where the opinions of respondents were equally divided: 55.7% of respondents rated the project positively, 44.3% reacted negatively to this project. Many of the respondents poorly understand not only the project itself, but also the problems that arise in connection with its implementation.

## 5 Conclusion

An alternative to solving the above problem is the process of collecting garbage separately, as well as further sorting and processing. The main problem in this process has always been the reluctance of residents to comply with separate collection rules, although the results of a sociological survey showed the opposite. Here, apparently, the desire is at variance with the fulfillment of this in practice.

The circular economy is an economic system aimed at eliminating waste and the constant use of resources. In

Russia, the transition to a circular economy is included in the long-term concept of sustainable development. This concept has existed since 2008. The purpose of the concept is to modernize the national economy through the introduction of innovations, and the creation of environmental development programs for the country.

To move to a model of a circular economy, it is first necessary to actualize the problem of municipal solid waste among the country's population.

Secondly, an important factor is the motivation for changes in this area. The motivational part may be new government programs for accruing bonuses for the proper sorting of garbage, which in the future can be spent on utility bills or food. It is also worth considering the socially unprotected layer of the population, for example, retirees or low-income families, and provide them with benefits.

Thirdly, training will be an important sector in this situation. Every resident of the country should be informed and trained in the proper sorting of garbage. One of the options may be special technical devices for each container, which will automatically voice the instructions or determine by the barcode of the product to which container this waste should be sent. You can also install special containers for waste such as batteries. An important motivation factor can be automated machines in stores that will return the cost of plastic packaging when it is delivered.

A possible option for implementing such a system may be a system of high fines. However, if we inform the population about the current situation, conduct training, we believe that the transition to a circular economy model is real.

## References

- [1] L. Shubov, O. Borisova, I. Doronkina, *Ekologiya promyshlennogo proizvodstva*, **3**, 8-13 (2017) [Electronic recourse]. Available at: <https://elibrary.ru/contents.asp?id=34536525&selid=30042713>.
- [2] O. Gromova, A. Papoian, *Zhurnal issledovaniy poupravleniiu*, **5**, 3-6 (2019).
- [3] K. Boulding, H. Jarrett, John Hopkins University, Baltimore (1966).
- [4] Ellen MacArthur Foundation, *Towards a Circular Economy: Business Rationale For An Accelerated Transitio* (2015).
- [5] N. Svitoch, *Tviordyebytovye othody, Otrasleyvedomosti*, **2** (2007).
- [6] D. Willson, *Tviordyebytovye othody, Otrasleyvedomosti*, **3** (2007).
- [7] S. Shpilevaia, *Obrazovaniye vospitanie*, **5**, 55-59 (2017).
- [8] A. Chalganova, *Nauka i biznes: putirazvitiya*, **6**, 137-140 (2017).
- [9] M. Sher, RT [Electronic resource]. Available at: <https://russian.rt.com/russia/article/636728-protesty-musornye-poligony-arhangelsk>.
- [10] L. Larchenko, R. Kolesnikov, *IJEEP*, **7**, 2, 352-359 (2017).

- [11] L. Larchenko, R. Kolesnikov, G. Tumanova, V. Kibenko, IJEEP, **6**, 529-536 (2016).
- [12] A. Prianikova, A. Akhmadieva, A. Khrustaleva, IEEE, 8554102 (2018).
- [13] V. Samarina, T. Skufina, A.Samarin, D. Ushakov,IJEEP, **8**, 140-147 (2018).
- [14] N. Batova, P. Sachek, I. Tochitskaia, *BEROC Green Economy Policy Paper Series* (2018).
- [15] V. Aleksandrova, O. Abramova, *Mezhdunarodnyi nauchny i elektronnyi zhurnal "Sinergiiianauk"*, **31** (2019).
- [16] Ya. Vaisman, *Upravlenie othodami, Stochnye vody i biogas poligonov zahoronniya tverdyh bytovyh othodov* (2012).
- [17] N. Pahomova, K. Rihter, M. Vetrova, *Vestnik SPbUE*, **33** (2017).
- [18] L. Larchenko, Yu. Gladkiy, V. Sukhorukov, *IOP Conference Series: Earth and Environmental Science*, 012121 (2019).
- [19] M. Razakova, M. Dushenko, *Geoinformatika*, **2**, 48-52 (2017).
- [20] L. Melinova, A. Kaverin, A. Sedlov, N. Melinova, *Novoe v rossiiskoelektroenergetike*, **5**, 12-21 (2019) [Electronic recourse]. Available at: <https://www.elibrary.ru/contents.asp?id=37845610&selid=37845614>.