Introduction of innovative technologies - a factor in the development of the waste management industry in Russia

Natalia Putinceva1*, Olga Kim1, Elena Voronina1, Elena Fugalevich1, Marina Mikhailova1, Elena Ushakova2
1 Saint-Petersburg State University of Economics, Sadovaya, 21, Saint-Petersburg, Russia
2 Saint-Petersburg University of Management Technologies and Economics, Lermontovsky Prospekt, d. 44, Saint-Petersburg, Russia

* E-mail: p.i.r@rambler.ru

Keywords: eco-technopark, waste recycling, waste sorting, smart container, smart garbage collector, digitalization

Abstract: In recent years, many countries experiencing the global financial and economic downturn have been actively searching for new models of development. Creating a waste management industry in Russia is another sector of the "green economy" that can solve not only the country's environmental problems, but also can create new points of growth, create new jobs and ensure economic growth. Eco-technoparks (there are about 300 such parks in the world today) should become the basis of the waste management industry. Foreign and Russian experience in the operation of eco-technoparks allows us to identify certain regularities and success factors for their activities, and to promote the growth of the number of eco-technoparks. The waste management industry is now also becoming a driver of the digital economy. At the same time, the process of digitalization of the waste management industry is a real opportunity to move to a differentiated system of payment for municipal waste management services, and, accordingly, the opportunity to solve the industry's problems. In order to develop the waste management industry, it is necessary to define the concept of eco-technoparks and secondary resources as an important condition for providing state support to eco-technoparks. The article gives the author's definition of eco-technology parks.

1. Introduction

As the world experience shows, waste recycling creates 10 times more jobs than traditional landfills. With the creation of 100 new jobs in the field of waste recycling, the number of jobs in the traditional waste management sector is reduced by only 10. In 2010, the waste recycling industry in the United States provided 460,000 jobs with a payroll of $26 billion. The value of products and services produced by the industry exceeded $90 billion, which is comparable to the volume of publishing or coal mining activities. The U.S. recycling industry is among the top ten fastest-growing industries, with a growth rate of 11% in 2016. A 1% increase in the recycling rate creates about 35,000 jobs [1].

The world experience also shows that from 100% of solid municipal waste (MSW) it is possible to obtain 5% of secondary material resources, 25% of certified fuel for cement plants or complexes for the production of electrical and thermal energy, 40% of compost, artificial soil and only 20% - is the remainder to be disposed of at the landfill. [2]

On average, about 5.4 billion tons of waste is generated in Russia annually, including about 71 million tons of municipal solid waste, up to 80% of which is goods and packaging, of which less than 7.5% is recycled, and up to 85% of MSW waste is disposed of in landfills (mostly unsanctioned). In the process of MSW disposal in the Russian Federation at least 9 million tons of waste paper, 2 million tons of polymeric materials and 0.5 million tons of glass are irrevocably lost annually. Approximately 15,000 authorized waste disposal facilities occupy a total area of about 4 million hectares, and this area increases annually by 300,000 to 400,000 hectares [3].

Growing problems with MSW utilization led to the appearance on 25 January 2018 of the "Waste Treatment, Utilization and Decontamination Industry Development Strategy for the period up to 2030" (hereinafter referred to as the Strategy), approved by the Government of the Russian Federation, No. 84-r. The Strategy provides for a set of measures to develop the system of recycling of waste, tightening of
environmental requirements on the one hand, and provision of support measures to those entrepreneurs who will implement innovations on the other hand. The strategy gives eco-technoparks the status of a key element in the development of the waste management industry and the secondary resource industry.

Ecotechnoparks are defined as industrial symbioses, functionally linked enterprises that will not only process waste, but also produce final products or secondary raw materials. Eco-technoparks seek to exchange material and energy resources through a planning system to minimize resource consumption, reduce waste emissions and establish a sustainable relationship between economic, environmental and social aspects [4]. The profits generated by technology parks should be a major source of investment in waste. The strategy also recognizes that the lack of separate accumulation and sorting of waste in the Russian Federation is one of the main obstacles to establishing a waste management industry. Only the introduction of separate waste accumulation (hereinafter referred to as SWA) can provide the maximum selection of secondary resources from MSW.

As the experience of the USSR and foreign experience shows, the introduction of SWA in the source of formation is a priority task for optimization of the MSW management system [5]. Separation of the whole mixture of unseparated MSW leads to excessive costs, loss of valuable components and contamination of potential raw materials requiring pre-treatment operations before their inclusion in production, which significantly complicates the process. Availability of infrastructure for collection of available volumes of actually collected waste is an objective factor of appearance and a real incentive for the development of the waste processing industry. Therefore, separate collection is the basis for solving the problem of rational use of resources and reducing the amount of residual waste that requires further disposal operations, as well as the basis for the effective functioning of eco-technoparks.

According to the second Greenpeace Russia rating on the accessibility of SWA infrastructure for residents, only 14.5% of residents of large Russian cities, or 10.7 million people, have access to SWA infrastructure (in Moscow - 11% of residents, in St. Petersburg - 2.3%) [6].

Practice also shows that those management companies that introduce the SWA system only through the collection of PET-bottles by 15-20% reduce the volume of MSW, while the collection of glass, paper and textiles further reduces the volume of MSW by 40% [7].

And Russian citizens are ready to sort their garbage. According to All-Russian Public Opinion Research Center data, 27% of Russians regularly sort garbage, 13% of citizens do it from time to time, and 46% of respondents are ready to sort garbage when they have the opportunity. 23% of citizens of the Russian Federation constantly take dangerous garbage to special receivers, including batteries, used electronics and mercury lamps, 10% do it periodically and 57% of Russians expressed their readiness to do it if possible. Only 11% of respondents are skeptical about sorting waste and do not want to do it [8].

2. Innovative technologies in the field of waste management

2.1 Key factors in eco-technology parks

Eco-technoparks play an important role in the closed-loop economy, which is recognized as the most economical and energy efficient type of economy, consider Gomez Alberto, Gonzalez Federico and Barcena Miguel [9].

Increasing the energy efficiency of the national economy and reducing its negative impact on the environment through the creation of ecoinustrial parks noted Guohui Feng, Chuan Tian, Shuai Li and Fuqiang Xu in the study "Research on Influence Factors of Building Energy Efficiency and Environmental Protection in Industrial Park in Shenyang" [10].

Li Wenbo sees the development of ecoinustrial parks as a significant contribution to the formation of a "circular economy" (Circular Economy), which is currently proposed by the scientific community as an ideal model of the national and world economy as an economy based on the renewal of resources [11].

Subbotina E.V., Tyutyuk O.V. and Martyanov N.S. in the article "Integrated approach to management of secondary resources use at the regional level" note that Increasing the efficiency of the use of natural and economic potential of the territory, including on the basis of capitalization of secondary resources, is one of the main objectives of modern Russia [12].

Boyko V.A. in his research work "Information support for management of collection and processing of secondary resources» makes a conclusion that the developed countries of the world and Europe have achieved much higher levels of waste utilization as secondary material resources due to the development of eco-industrial parks and plan to completely stop waste disposal in the future [13].

Based on the study of the development of the regional forest complex of the Republic of Komi Karimov D.K. notes that the eco-industrial park, aimed at the forest sector, will help the republic to solve many problems and direct its development along a sustainable path [14].
Filotov V.V., Rukina I.M., Golovanov V.I. in their researches draw a conclusion that the projects of ecological industrial parks have great territorial potential and positive infrastructural influence on the development of the region, in particular, the standard of living and investment attractiveness of the region is increased, entrepreneurial activity is activated. [15].

The review of materials on the theme of formation and development of ecoindustrial parks allows us to draw a conclusion that eco-technoparks are really the most rational infrastructure object, which is able to solve the accumulated socio-economic and environmental problems of modern regions of the world.

Creation of eco-technoparks should also become one of the mechanisms of restoration of scientific and technical potential, development of scientific and production activity in the sphere of resource saving, processing, utilization and neutralization of wastes in Russia. Available foreign experience of functioning of eco-technoparks allows to adjust the activity of eco-technoparks in Russia in optimal terms. Large eco-technoparks (there are about 300 such parks in the world today) are: Japan (Kitakyushu, Kawasaki, Minamaka, Aichi), South Korea (Penang, Seoul), China (Caofeidian Eco-city), Germany (Freiburg), England (Liverpool, Manchester), Canada (Edmonton), Australia (Sydney) and Brazil (Curitiba). Due to the lack of standardized methods for measuring the performance of eco-technoparks, it is not possible to assess and compare them among themselves. Only Chinese legislation is the only example of formulating a national set of indicators to assess the performance of ecoparks, through the assessment of resource efficiency and the reduction of emissions into the atmosphere, wastewater and solid waste per unit of value added, and the increase in the water reuse factor.

The study of different models of eco-parks shows that development strategies, action plans, products, product families, processes, materials, and technologies, as well as economic and environmental aspects of such facilities around the world are almost identical. The activities of eco-technoparks differ only in approaches to organization, management and legal support related to national, geographical and economic peculiarities of different countries. All eco-technoparks are implemented by three main tasks, which are detailed in the process of activity:

- Reduction of resource consumption;
- Reducing the environmental impact through the organization of exchange relations between the participants of industrial symbiosis (Fig. 1),
- Obtaining economic benefits, sustainable regional development.

![Figure 1: Example of industrial symbiosis in Kalundborg, Denmark [16]](image-url)
A distinctive feature of eco-technoparks is the individuality of creation of each of them. Eco-technoparks were more often created spontaneously, as a result of interaction of several industrial objects and (or) city structures, but the role of the state at the initial stage of project development and launch of the object has always been decisive. Modern eco-technoparks are created either on the basis of the main (parent) enterprise or group of enterprises, or as objects aimed at solving a certain problem of the district, region, city (for example, effective waste management, water resources, forest fund, energy efficiency, etc.). In accordance with the above, all eco-technoparks can be classified as:

- Industrial parks;
- Urban parks;
- Combined complexes.

Depending on the level of localization, eco-technoparks can be:

1) Federal eco-technoparks, end products are made in the park from recycled materials supplied from regional eco-technoparks;

2) Regional eco-technoparks, whose activities are aimed at minimization of waste disposal through selection and utilization of valuable components, decontamination of organic, medical and biological waste and disposal of only certain types of waste (the share of decontamination and utilization is 60-80%);

3) Corporate or municipal eco-technoparks, whose activities are primarily aimed at solving urgent problems of the city community [17].

The main element of eco-parks is the exchange of resources between companies. There are three main types of exchanges in an eco-technology park:

- Recycling of by-products/waste (exchange of product-specific materials between two or more companies to replace the use of commercial products or raw materials);
- Sharing of utilities/infrastructure (sharing and management of resources such as energy, water, electricity and heat, and joint operation of wastewater treatment plants and gas treatment equipment) [18];
- Joint provision of services (satisfaction of common needs of companies with regard to implementation of auxiliary activities, such as fire safety, transportation and others).

A resident (lessee) of eco-industrial parks is an enterprise that participates in industrial symbiosis and/or uses integrated services of eco-industrial park (administrative, infrastructural), industrial enterprise receiving water, energy and material resources as raw materials and products, water, energy and waste [19].

The analysis of existing eco-technoparks and industrial ecosystems at the regional level allows us to identify certain regularities or success factors of their activities, the use of which may contribute to the emergence of new such objects, including in the territory of the Russian Federation (Table 1).

| Factors of success                                      | Description                                                                 |
|--------------------------------------------------------|-----------------------------------------------------------------------------|
| Economic value added                                   | Reducing costs and/or increasing profits through synergies with other companies in the eco-technology park |
| Organizational and institutional support               | Active state policy aimed at introducing environmental innovations, developing industrial symbiosis, including by involving regional and local administrative structures |
| Financial incentives                                   | Tax cuts, financial support for companies implementing innovative technologies, reduction of rent, etc. |
| Establishment of a coordinating body                   | Establishment of a coordinating body to facilitate inter-firm contacts and effective cooperation, as well as to act as a single point of management for joint infrastructure and service organizations serving the eco-technology park |
| Cooperation with research institutes                  | Cooperation contributes to the development of eco-innovative technologies and rapid transition from pilot projects to industrial production |
| Geographical factors and developed regional infrastructure | Location near the urban infrastructure or industrial facilities, a large transport hub, port is an advantage in the design of new eco-technical parks or the development of existing industrial systems |
| Options for economic activity                          | Option provides more opportunities to create a multitude of "reciprocal" linkages between enterprises with different types |
A number of experts believe that eco-parks can become key elements of Industry 4.0 [21]. Russia also has experience in creating eco-technoparks, which were more often called eco-industrial parks before the Strategy. Eco-technoparks are already in operation in the Perm, Kurgan, Volgograd, Astrakhan and Rostov regions. In the future, we will launch eco-technoparks in Nizhny Novgorod, Novokuznetsk Region, South Ossetia and Adygea. Currently, ten regional eco-technoparks with a total capacity of more than 2 million tonnes per year are at various stages of operation, construction and design in the Southern Federal District, with full completion of construction by the end of 2018 (in the Volgograd, Astrakhan, Rostov regions and the Republic of Kalmykia). The project, which is being implemented by the Clean City State Corporation, envisages a two-tier system of eco-technoparks, regional and federal, with minimal use of budget funds and whose experience is particularly interesting in the absence of real forms of support for the development of enterprises working in the field of waste management [22].

At the moment, the only real form of support for enterprises in the field of waste can be considered only the Decree of the Government of the Russian Federation of 25.05.2017 № 634 "On providing subsidies from the federal budget to Russian organizations to compensate for part of the cost of production and implementation of pilot batches of production facilities to consumers", which is partly aimed at supporting enterprises (environmental) machine-building. Financial support is provided mainly in the form of subsidies to compensate for the cost of paying part of the interest rate on loans or to reimburse part of the costs incurred for the production of industrial products. At the same time, the legislation sets rather strict requirements for the recipients of subsidies. For example: requirements are placed on the volume of future sales of eco-technoparks (in some cases, the volume of sales in the first 3 years must be 10 times higher than the volume of subsidies received). However, these requirements should be as soft as possible for waste treatment projects, as the market for recycled products is still in its infancy.

At present, the Investment Project of Rostec State Corporation is being implemented in the waste management industry: "Development and implementation of a pilot project on construction of thermal treatment facilities for MSW in Moscow region and Kazan city". The investment project involves the construction of 4 MSW thermal treatment plants in the Moscow Region with a total capacity of 2.8 million tons of MSW per year and one plant in Kazan with a capacity of 550 thousand tons of MSW. Implementation of the Project will allow to reduce the volume of buried MCI in the Moscow Region by 30% within 3-5 years, which corresponds to a decrease in the volume of burial by 7% on the territory of Russia. In addition, the Investment Project will make a significant contribution to the development of the Russian industry: at the initial stage, the level of localization of thermal treatment equipment production may reach 50% and will create demand for Russian infrastructure contractors and construction companies in the amount of 65 billion rubles in 2017-2020.

The Russian Ministry of Industry and Trade is also implementing a Departmental project to create Russian automated high-tech complexes for processing and disposal of production and consumption waste in the amount of 6 units by 2020 and an additional 37 units by 2030. The Departmental project involves localization of production of automated complexes for processing and disposal of production and consumption waste up to 75% by 2020, up to 90% - by 2029 at the production facilities of JSC "CRISM "Burevestnik" [23].

### 2.2 Advantages of the digitalization of the waste management industry

The waste management industry is now also becoming a driver for the introduction of digital technologies. According to Frost & Sullivan, by 2020 the global digital transformation market in the field of MSW management in monetary terms will increase to $3.6 billion, compared to $3.3 billion in 2017, with an average annual growth rate of 2.74%. Data of the world turnover of the digital technologies market by segments of the waste processing industry are presented in the table 2.

| Industry segments                  | 2017 | 2020 | 2030 |
|-----------------------------------|------|------|------|
| Gathering                         | 96   | 108  | 368  |
| Transportation                    | 225  | 252  | 538  |
| Software development              | 2864 | 3015 | 3360 |
| Smart recycling systems           | 138  | 232  | 647  |
According to Table 2, the largest digital technology market segment in the waste management industry remains the development of cloud computing platforms, user interfaces and software. At the same time, the rate of digitalization remains one of the highest in the segment of MSW processing.

The development of digital technologies in the waste processing industry is currently taking place in four main areas around the world:

• production of smart systems for waste collection ("smart containers"),
• Optimization of supply chains and equipping the vehicle fleet with specialized software and sensors ("smart garbage collectors"),
• Production and introduction of intelligent systems for processing and disposal of MSW
• Development and application of cloud technologies and user interfaces. The largest number of smart technologies and waste management equipment is now being developed in Western Europe and North America. In addition to "smart" containers and garbage collectors, they also include robotic systems for sorting MSW, specialized mobile applications, accounting and analytics systems, software, etc.

At the same time, the process of digitalization of the waste management industry is a real opportunity to switch to a differentiated system of payment for the services of MSW management and to solve the tasks of the waste management industry.

Currently, the majority of MSW collection operations are focused on regular scheduled removal of house containers. However, this approach is ineffective, as containers can be either semi-empty or overcrowded. As a result, waste disposal operators spend extra fuel (in the case of half-empty containers) or have to re-exit (in the case of overcrowded containers). Intelligent waste collection solutions can track waste levels in containers and provide operational analytics and route optimization, reducing operating costs.

The common set of elements in most intellectual systems of MSW collection includes:

• Sensors that monitor the level of filling and other indicators (temperature, humidity, etc.);
• Wireless modules for data transmission;
• Data management software.

Sensors are mounted on each waste container to indicate its fullness. Sensors connected to the wireless communication networks and using batteries or solar energy as power sources send information to the waste analysis platform server about the need to empty the tank.

Garbage dispatchers can view the information in the mobile application themselves or wait for SMS or push notifications to be sent to the smartphone, tablet, email, etc. The data is analyzed by the analytical platform, and the results of garbage collection are displayed in the form of graphs and tables. Based on historical data and intelligent algorithms, the platform is able to provide forecasts of the level of filling for further optimization of operations.

The combination of solar powered tanks and the analytical platform can reduce the operational costs of waste collection by up to 80%. Special software in the control room selects the best route for each garbage collection vehicle based on the road situation. Using historical data, the system can predict the occupancy of each tank, the optimal routes and periods for its cleaning.

The benefits of introducing a "smart bin":

• prompt maintenance of containers as needed or requested by citizens through a special application;
• Optimization of the working schedule of employees;
• Minimization of fuel consumption and idle trips;
• Optimization of special equipment fleet due to the optimal schedule of garbage disposal;
• Reduction of operating and maintenance costs;
• Withdrawal of the waste disposal industry from the grey area. [25]

New York City already has experience with "smart trash cans", which are equipped with an integrated press, and solar power is used as a source of power for the batteries. Each garbage compression command is performed by a "smart garbage can" autonomously. Sensors also provide the utilities with information that the bin is full. Compology experts report that such systems can reduce waste collection costs by up to 40%.

Similarly, the garbage problem has been solved in the South Korean capital, Seoul. In just three months of using waste management solutions, the city has been cleared of waste. The city’s MSW collection service has been able to set up effective schedules for collecting and cleaning the waste bins.

The beginning of digitalization of the waste management industry in Russia was initiated by the May decrees of the President of Russia («On the national goals and strategic objectives of development of the}
Russian Federation for the period up to 2024», dated May 7, 2018). The document includes a separate national project "Ecology".

By the end of 2019, about 50 regions of Russia should switch to new software (Big Troika). The introduction of the new software should ensure fair prices for waste removal for all market participants by optimizing logistics flows and making the location of waste processing plants and landfills more rational. The software has already demonstrated its effectiveness: the new electronic model of the territorial waste management system in Udmurtia turned out to be more profitable than the scheme previously proposed by the regional operator. As a result, the initial monthly tariff of 166 rubles per person decreased to 135.25 rubles [26].

However, digitalization is penetrating not only into the sphere of MSW export. Employees of the Kutateladze Institute of Thermal Physics will develop a sorting conveyor with a waste collector and automatic sorting by 2020 [27]. An optical system will be installed on the conveyor, which will automatically recognize waste by color, type and other criteria, and a robotic hand will distribute waste to different containers.

The Novosibirsk development has no alternative in Russia. The system will be managed using artificial intelligence, and the role of man in the updated process will be relevant only during the period of machine learning. Thus, developers note, the system will be ecologically safe.

3. Separate accumulation of municipal solid waste is a prerequisite for effective implementation of innovations in waste management

The review of materials on the theme of formation and development of ecoindustrial parks allows us to draw a conclusion that eco-technoparks are really the most rational infrastructure object, which is able to solve the accumulated socio-economic and environmental problems of modern regions of the world.

In our opinion, all definitions of eco-technoparks overlook one detail that eco-technoparks should not only produce products from secondary raw materials, but also should ensure the sale of these products. Today, when there are no separate waste accumulation systems in Russia, the selected secondary raw materials are of very low quality and do not always find a consumer. Therefore, we propose the following definition of eco-technoparks:

Eco-technopark is a complex of technological solutions, equipment, facilities providing a single technological process and functioning on the basis of the principle of separate accumulation of waste, the ultimate goal of which is the production and sale of products from secondary raw materials.

No. 503-FZ "On Amendments to the Federal Law No. 89-FZ and Certain Legislative Acts of the Russian Federation" dated December 31, 2017 contains a number of positive aspects that stimulate the process of waste management, but the document declares the "permissive" rather than "mandatory" nature of SWA throughout Russia. The document does not contain any real measures to encourage the organization of SWAs for either business or citizens, despite the fact that this document is considered the starting point for separate waste collection in Russia.

The Strategy also says nothing about the development of the SWA system. The strategy aims to process, sort, sort, sort, press, pack, etc., and then dispose of and neutralize waste, and declares the relevant targets. However, such a target indicator of the Strategy as "the share of recycled and neutralized waste in the total volume of waste generated" does not allow us to understand the direction of development of the waste management industry. Such wording is suitable for the development of secondary raw materials and the return of materials to the resource cycle, and for the development of waste disposal technologies. And under the technologies of waste neutralization can be understood the receipt of compost and biogas, and maybe just burning.

In addition to the Strategy, the overwhelming number of territorial waste management schemes and regional waste management programs (regional operator), which are necessary elements of the development of waste management, also do not contain clear targets for the implementation of SWA. As a result, the majority of regional operators ignore the creation of SWA infrastructure and begin to build schemes for working mainly with mixed waste, extracting secondary raw materials from them at sorting stations and then selling them.

But even in those regions where the territorial scheme assumes SWA, waste sorting is organized on the principle of "single stream", in which it is proposed to dispose of waste into "two buckets": the recycled materials indicated on the plates and everything else. Secondary raw materials collected in this way still need to be sorted, and "everything else" still contains many useful fractions, such as food waste. As a result, an absolutely inefficient system (sorting of mixed MSW) is being replaced by a simply inefficient system (sorting of secondary raw materials).
In addition, the organization of SWA is unprofitable for the regional operator itself for the following reasons:

- the tariffs of the regional operator for the population include only the cost of transportation, processing, neutralization and burial of waste plus a fixed part of the earnings of the regional operator; the costs of creating the infrastructure of the SWA are borne by the operator itself, for which the regional operators are mostly not ready;
- The income of the regional operator depends on the imported mixed MSW;
- the cost of secondary raw materials is excluded from the gross revenue of the regional operator;
- Subsidies from the state budget for the regional operator are provided only for the construction of waste sorting facilities and waste disposal capacities, but not for the creation and maintenance of infrastructure for SWA.

There are regions in Russia, for example, the Leningrad Region, where the Procedure for collection (accumulation) of MSW (order of 6 July 2017 N 6 of the Department of the Leningrad Region for organization and control of waste management activities), including a separate one, specifies the need for the introduction of SWA through the "single stream" system, and the tariff for the regional operator includes the cost of purchase and maintenance of container sites for SWA. But there are not many such regions.

In September 2018, by the Government Decree, the Rules for Determining the Norms of MSW Accumulation (approved by the Government Decree No. 269 as of 4 April 2016) were supplemented with provisions on the possibility of differentiating the norms of MSW accumulation by types and groups of waste. This document is able to stimulate the society to the development of SWA. The introduction of differentiated standards of accumulation means that the fee for the service of handling MSW will be charged in accordance with the actual volume of garbage removed, but not according to the norm. However, differentiated tariffs will stimulate the development of separate accumulation of waste only if the difference in tariffs for the population for sorted and unsorted waste will be quite high. In this case, the "polluter pays" mechanism will work. Based on foreign experience, only the introduction of payment for the service of MSW physical education in Europe has been developed by the SWA system [28].

4. Conclusions

As a whole, conditions have been created in Russia for the development of the waste management industry. The formation of the waste management industry is a necessity, and there may be no landfill sites around large cities in the coming years, but on the other hand, it is an opportunity to create new points of growth in the economy and create new jobs.

The introduction of innovative technologies, including digital technologies, is a key factor in the development of the waste management industry. Introductions of "smart containers", "smart garbage collectors", intelligent systems of recycling and disposal of TKOs, cloud technologies and user interfaces - a real opportunity to move to a differentiated system of payment for TKO services, to solve the problems of the industry of waste management. Intelligent waste collection solutions are able to monitor waste levels in containers and provide prompt analysis and route optimization, reduce operating costs, and, accordingly, significantly reduce the tariff for garbage collection and encourage active implementation of the RNO system.

To date, in order to stimulate activities in the field of waste, it is necessary to define the concept of eco-technoparks and secondary resources as an important condition for providing state support to eco-technoparks, including in the organization of public procurement. The use of the author's definition of eco-technoparks, which includes the principle of mandatory separate accumulation of waste, would ensure the most effective development of waste recycling.

Refinement of the extended producer responsibility (EPR) mechanism in Russia will also help to increase demand for waste sorting as a key function of eco-technological parks. The EPR rates are currently the subject of heated discussion among environmentalists and producers (importers) of products and packaging. For comparison, Table 3 presents the environmental levy rates in Russia and the European Union.

| Waste groups/ Eco-collection rate (rub./tonne) | Paper and cardboard | Plastic | Tare metal | Glass |
|---------------------------------------------|---------------------|---------|------------|-------|
| Russia                                      | 2376                | 3844    | 2423       | 2564  |
| European Union                              | 2659                | 14863   | 9749       | 3068  |
The data in Table 3 and the opinions of experts point to rather low rates of environmental levies in Russia, especially for such packaging groups as plastic and metal packaging. However, in order to stimulate the development of the waste management industry, producers' waste disposal costs should be lower than the amount of the environmental levy. The low rates of the environmental levy encourage producers to pay the environmental levy instead of building the infrastructure of the waste management industry and eco-parks.

With regard to the environmental levy, the German experience is exemplary, as there is no possibility of paying the environmental levy for EPR participants at all. Manufacturers are obliged to dispose of their products and packaging in accordance with established recycling standards, regardless of how much this disposal will cost the "polluter" [30]. In order to help the producer, German municipalities are obliged to ensure separate collection of almost all types of waste, except for packaging and packaging, the collection of which is provided by the "polluters" themselves. In addition, there are targets for separate waste collection and disposal in Europe, which the EU imposes penalties for failure to achieve.

The experience of not having an environmental levy in Germany would be very relevant for Russia. The obligation of producers (importers) of products and packaging in the EPR only to dispose of waste can become a powerful incentive for the development of the waste management industry, instead of dumping waste, to accelerate the process of construction of eco-technical parks.

The introduction of SWA can provide maximum effect from the introduction of innovations in the field of waste management. The development of SWA in Russia requires adjustments to the existing target indicators of the Strategy to increase the level of recycling of secondary material resources. Indicators of SWA development should become:

1. Share of container sites for separate accumulation of secondary material resources and food waste.
2. Number of residents with one container site.
3. Share of secondary material resources collected separately to the total number of MSW formed by fractions: polymers, waste paper, glass, metal, textiles, etc.
4. The share of waste aimed at composting and biogas production to the total amount of generated MSW. From the point of view of sustainable development, the MSW composting method is higher than the method of biogas extraction from waste, so ideally this indicator can also be broken down into two more specific indicators.
5. Elimination of the target for decontamination, including incineration, pyrolysis, gasification and similar resource destruction methods.

Organization of separate accumulation of waste is a personal responsibility of each citizen of the country, an indicator of the maturity of civil society.

References

[1] Mariev V A, Smirnova T G 2017 Formation of eco-technoparks in the conditions of the Russian Federation (in Russian) Solid wastes 3 21-23
[2] Taddeo R 2016 Local industrial systems towards the eco-industrial parks: the model of the ecologically equipped industrial area J. of Cleaner Production 131 189-197
[3] Strategy for the development of industry for processing, recycling and neutralization of production and consumption waste until 2030 Order of the Government of the Russian Federation No. 84-r, 2018.
[4] Jen - Te Pai, Di Hu, Wan - Wen Liao 2018 Research on eco-efficiency of industrial parks in Taiwan Energy Procedia 152 691-697
[5] Korsanov S A, Mustafin G V 2014 World and Russian experience of solid waste disposal Vestnik of Omsk University Economy series 2 114–120
[6] Kommersant 2018 «Greenpeace Russia» sorted waste per capita https://www.kommersant.ru/doc/3535354 Accessed on 28 September 2019
[7] Rossiyskaya gazeta 2017 In NWFD they are switching to a new system of waste processing https://rg.ru/2017/08/01/reg-szfo/v-szfo-perejdut-na-novuuusistemu-pererabotki-othodov.html Accessed on 28 September 2019
[8] Interfax 2019 Less than a half of Russians were ready to switch to separate waste collection https://www.interfax.ru/russia/645538 Accessed on 25 September 2019
[9] Gomez A, Gonzalez F and Barcena M 2017 Smart eco-industrial parks: A circular economy implementation based on industrial metabolism Resources, Conservation and Recycling (In press, corrected proof, Available online 12 September 2017)
[10] Guohui F, Chuan T, Shuai L and Fuqiang X 2017 Research on Influence Factors of Building Energy Efficiency and Environmental Protection in Industrial Park in Shenyang Procedia Engineering 205 702–708

[11] Wenbo L 2011 Comprehensive evaluation research on circular economic performance of eco-industrial parks Energy Procedia 5 1682-1688

[12] Subbotina E V, Tyutyuk O V and Martyanov N S 2014 Integrated approach to management of secondary resources use at the regional level Vestnik PGU. Series: Economy 2 53-62

[13] Boyko V A 2008 Information support of the secondary resources collection and processing management (in Russian) Interexpo Geo-Siberia 2 36-44

[14] Karimov D K 2015 Ecoindustrial Park as a vector of development of the forest sector of the Republic of Komi Komi Republican Academy of Public Administration and Management (Syktyvkar). Conference materials 51-54

[15] Filotov V V, Rukina I M, Golovanov V I 2018 Revitalization of urban areas on the basis of ecological industrial parks Municipal Academy 3 158-166

[16] Kalundborg Symbiosis. Effective industrial symbiosis https://www.ellenmacarthurfoundation.org/case-studies/operative-industrial-symbiosis Accessed on 25 September 2019

[17] Liubarskaia M A, Tsurkan M V, Vorotnikov A M 2018 Implementation of project management in eco-industrial parks development in Russian cities IOP Conf. Ser.: Earth Environ. Sci. 177 012039

[18] Ramos M, Boix M, Aussel D, Montastruc L and Domenech S 2016 Water integration in eco-industrial parks using a multi-leader-follower approach J. Comp. & Chem. Eng. 87 190–207

[19] Zhou L, Pang M, Sikorski J, Garud S, Kleinelandshorst M, Karimi I and Kraft M 2017 System development for eco-industrial parks using ontological innovation J. Energy Procedia 105 2239–2244

[20] Mariev V A, Smirnova T G 2017 Factors of success of eco-technoparks in the world Solid waste 2 (128) 14-18

[21] Zhou L, Zhang C, Karimi I and Kraft M 2017 J-Park Simulator, an intelligent system for information management of eco-industrial parks. J. Energy Procedia 142 2953-2958

[22] Vergun P. 2018 Development of systems for a closed cycle of waste management Solid wastes 2 52–53

[23] Report on the goals and objectives of the Ministry of Industry and Trade of the Russian Federation for 2018 and the main results of activities for 2017 https://nangs.org/docs/minpromtorg-rossii-doklad-o-tselakh-i-zadachakh-minpromtorga-rossii-na-2018-god-i-osnovnykh-rezultatakh-deyatelnosti-za-2017-god-pdf Accessed on 24 September 2019

[24] itWeek 2018 Digital transformation in waste processing: market, trends and prospects https://www.itweek.ru/digitalization/news-company/detail.php?ID=203630 Accessed on 25 September 2019

[25] News of Internet of Things 2019 New technologies for garbage collection https://iot.ru/gorodskaya-sreda/novye-tehnikologii-dlya-uborki-musora Accessed on 25 September 2019

[26] Tass 2019 More than half of the regions of the RF will switch over to the digital system of garbage disposal by the end of the year https://tass.ru/obschestvo/6910824 Accessed on 25 September 2019

[27] Titova I V, Astanin V K, Sidorenkov V L 2018 Digitization of production processes of waste utilization Conference materials Voronezh GAU named after Emperor Peter I 181-185

[28] Green Pravda 2018 The problem of separate waste collection in Russia is much wider than the tariffs of housing and utility services https://greentruth.ru/utilizatsiya-i-pererabotka/razdelnyj-sbor-musora/problema-razdelnogo-sbora-musora-v-rossii-gorazdo-shire-tarifov-zhku-ekolog/ Accessed on 25 September 2019

[29] Delovoy Peterburg 2017 Recyclers of waste paper are lobbying for a 4-fold increase in corrugated cardboard recycling rates https://www.dp.ru/a/2017/10/01/Denzi_jeto_karton Accessed on 25 September 2019

[30] Russian Taxes 2017 Environmental tax revenues in Germany http://www.taxru.com/blog/2017-11-22-27554 Accessed on 25 September 2019