

Perspective directions of development of waste processing enterprises in Khabarovsk

S A Sadredinov and M E Bazilevich

Pacific National University, 136, Tihookeanskaya St., Khabarovsk, 680035, Russia

E-mail: semyon933@gmail.com, mikhailbazilevich@gmail.com

Abstract. The article is devoted to the problem of the development of the waste processing industry and the prospects for the construction of enterprises for the disposal of municipal solid waste (MSW) in the city of Khabarovsk. A brief overview of current trends in the collection, disposal and recycling of solid waste, which in recent decades have become widespread both in central Russia and abroad, is given. The circle of existing problems in the field of solid waste management in Khabarovsk and its environs is outlined. Based on the data of the urban development analysis, specific recommendations on the development of the waste processing industry in Khabarovsk are offered. The possibility of building a network of enterprises of several types and generations for the disposal of solid waste in the city and its environs is being considered, which will solve the existing environmental, economic and social problems.

1. Introduction

The preservation of the environment is one of the key components of the sustainable development of any city. Favourable environmental conditions contribute to improving the safety and attractiveness of the urban environment, maintaining the health and comfort of citizens. In this regard, the problem of disposal and recycling of municipal solid waste (MSW) is becoming important.

For Khabarovsk, as well as for the Russian Far East as a whole, this problem is relevant for several reasons. Firstly, an outdated method of garbage processing - landfill is currently used in the region. Secondly, there is a shortage of specialized enterprises involved in the collection and disposal of solid waste, and existing enterprises do not meet the modern criteria for facilities of this type. In particular, technologies for the processing of solid waste for secondary use are not applied, the energy released during the burning of waste is not used, and such industries have a large ecological footprint. Another aspect of the relevance of the research topic is associated with its insufficient development, not only in practical but also in theoretical terms. Now, the scope of work devoted to the study of this issue in the Far East is limited mainly to news articles that only briefly outline the problem. As a result, this topic requires a more detailed and systematic study.

The purpose of the study is to identify promising areas for the development of enterprises for the pro-cessing of solid waste in the city of Khabarovsk.

2. Literature review

This study was based on a number of scientific and popular science works by Russian and foreign researchers, addressing various aspects of the problem of disposal and recycling of solid household waste, as well as on regulatory documents governing urban planning and environmental aspects of the garbage processing industry in the Russian Federation.



The problem of the improvement of the environmental situation through the construction of waste processing plants is considered in the works of Stokes J. R., Horvath A. [1], Sidorkina N. M. [2]. The authors conduct an environmental analysis and assess the damage to the environment using the traditional method of disposal of municipal solid waste. The works of Popov D. V. [3, 4] is devoted to the study of typology ("generations") and the inclusion of garbage processing enterprises in the urban environment. In these studies, the general principles of the development of the waste processing industry are identified, and a number of enterprises operating in the Russian Federation are studied. However, their work deals mainly with the experience of foreign countries.

The study of Yalovaya N. P., Trifonova N. G. and Yalovoy P. S. [5] gives an idea of the possibilities of using organically processed waste in landscape environment of urban areas. Based on foreign experience Sozykina E.V. [6] considers the principles and features of the location of treatment plants in the structure of urban development, without moving them outside the city limits.

The research works of Filatov V. V., Rukina I. M., Golovanov V. I. [7], Orlova T. [8], Luo H., Guo H. L., Gao Y. S. and Liu J. J. [9] are devoted to the development of innovative technologies for waste processing. Temelis N. J. [10] consider the possibilities of using the energy released during the burning of municipal solid waste, as exemplified by the USA.

Nevertheless, these works deal mainly with foreign experience in the development of the waste processing industry, as well as some examples of the construction of waste processing enterprises in central Russia, while the territory of the Far East remains outside the attention of researchers. This circumstance, of course, determines the relevance and novelty of this study on the prospects for the development of a network of waste recycling enterprises in the city of Khabarovsk.

3. Materials and methods of research

Various literary provided the materials for the analysis of current trends in the development of waste processing industry and construction of solid household waste processing enterprises and Internet sources devoted to this issue. The study of foreign and Russian experience in the field of solving the problem of waste processing allowed developing concrete proposals for the city of Khabarovsk and its surroundings, taking into account local conditions, including climatic peculiarities of the region, the existing transport network, as well as the close location of the city to the border with the PRC. The urban planning analysis carried out by the authors allowed determining the territories most suitable for the construction of waste processing enterprises of different types.

4. Results

4.1. Khabarovsk. Circle of problems

Currently, there is only one MSW processing facility in Khabarovsk - the Severnaya waste recycling station (WRS). This enterprise uses the method of compacting and disposing of solid waste at landfills and the waste is partially sorted, which allows up to 3 thousand tons of recyclable raw materials to be sent to China for further processing. Now, the station manages 70% of Khabarovsk waste, according to the administration of the Ministry of enterprise, the landfill will last for several tens of years. It should be noted that Yuzhnaya WRS was built but not put into operation on the territory of the city. This enterprise should improve the situation with the disposal of solid waste in the regional capital in future. At the same time, in the rest of the Khabarovsk Territory, garbage is recycled without sorting, just burning it. According to available data, 190 spontaneous garbage dumps are located on the territory of the city and in its environs; currently, the city administration is taking measures to eliminate them [11].

It should be noted that in the environmental ranking compiled by Domofond.ru analysts [12] based on a survey of residents of 200 cities of Russia, Khabarovsk took 109th place, located between Rybinsk (Yaroslavl Region) and Irkutsk (Irkutsk Region). For comparison, Moscow and St. Petersburg took 51st and 83rd places, respectively, Gelendzhik (Krasnodar Territory) takes the first place, and Norilsk (Krasnoyarsk Territory) takes the last. This circumstance indicates the presence of

serious problems in the region in the field of environmental pollution, including solid waste, and the need to develop a strategy to solve them.

4.2. Modern trends in solid waste disposal

If in the Khabarovsk Territory, landfills for disposal of solid waste are still being used, in the west of the country and abroad, more environmentally efficient and economically attractive technologies have long been developing. The study examined the experience of China, South Korea, Japan, Canada and the United States of America. These countries have about 30 years to develop technology for recycling and reuse of solid waste. The analysis allowed identifying the most common and current trends in the development of this industry:

- Waste sorting method. This method is widely used in many countries. MSW can be divided into several categories, each of which, in turn, can be further divided into subspecies. In different countries, garbage separation has its own specifics, for example, in China garbage is divided into four categories: “wet”, “dry”, recyclable, harmful, and in South Korea - into six: cans, paper, cardboard packaging; glass, PET bottles, aluminium cans. In addition, the country has an additional division of solid waste into household and food, they are sorted separately [13-15].
- The method of plasma gasification. It is used in South Korea, Japan, USA, Great Britain, India and other countries. MSW are processed by a plasma stream with a temperature of 1200 °C and above. At this temperature, no tar is formed, and toxic waste is destroyed. As a result, from 30 tons of garbage, 6 tons of ashes remain; they are cleaned and then used in construction. In addition, when burning garbage, thermal energy is released and then is used for electrification [16, 17].
- Garbage collection abroad. For a long time, China actively imported garbage for further processing from the USA, Great Britain and Germany, but with the recent change in legislation and toughening environmental standards, the import of solid waste into the country was significantly limited. This method is also used by Japan, sending part of its MSW for processing to the Philippines.
- Integration of garbage processing industries into the urban environment. Modern technologies make it possible to minimize environmental risks from waste processing industries, therefore there is no longer any need to take such enterprises outside the city limits [6]. As an example, consider a garbage recycling plant recently built in Copenhagen. The Copenhill plant and part-time power plant are capable of annually processing up to 440,000 tons of waste into clean energy. The enterprise belongs to the fourth generation and uses advanced waste incineration and air purification systems. The facility is located near the park and residential buildings. The building has a sports and entertainment center with a ski slope, rooftop hiking trails, and the highest artificial climbing wall in the world, located on one of the facades [18].
- Regeneration of territories. Territories of former dumps and landfills can get a second life thanks to new technologies for the restoration of contaminated land. An example of this is Freshkills Parks on Staten Island in New York, USA; Kumparepuisto in the city of Kotka, Finland; Moerenuma in Sapporo, Japan, created at the site of solid waste landfills [5].

In the Russian Federation, this industry is not developing so intensively, nevertheless, certain steps are already being taken towards the introduction and development of modern and efficient waste recycling technologies. Positive examples include a bottle-to-bottle plastic processing plant using PET technology built in Solnechegorsk, Moscow Region. The main feature of this technology is the complete identity of the quality characteristics of the products obtained (reconditioned PET or Clear PET brand RePET) with primary food grade PET raw materials. Clear PET is certified by the Moscow Region Hygiene and Epidemiology Centre for use in food packaging. The examples of regeneration of territories of former garbage landfills include a golf course built on the site of a former Moscow landfill in the floodplain of the Setun River, as well as a park project on the site of the Salaryevo municipal solid waste landfill area of 59 hectares.

Currently, there are 14 plastic processing plants for recycling in Russia, for comparison, in China - 12, Japan - 16 large, not including small enterprises, the United States - 22. Processing plants are located in central Russia, and most of them work for servicing Moscow and Moscow Region, while in other regions, landfill and ordinary waste incineration are used. However, garbage is also being delivered into the municipalities, which requires more and more space, since garbage production from the capital is growing every year, but residents of the regions are against expanding landfills, since they believe that it will worsen their environment [19].

4.3. Prospects for solving the problem of solid waste disposal in Khabarovsk

Returning to the Russian Far East, it should be noted that in Khabarovsk and the Khabarovsk Territory there are undoubtedly prospects for the development of this industry. The current norm of solid waste in the Khabarovsk Territory is 270 kg per person per year [20], which with a population of 1.3 million people means the production of 351 thousand tons of solid waste. Undoubtedly, such a volume of annually generated waste requires a competent approach to collection and disposal. With proper financial support and competent planning, the region will be able to free its territories from landfills, creating in their place modern recreational spaces and tourism facilities, and thereby improve the environmental situation.

The formation of a system of waste recycling enterprises in Khabarovsk will not only solve the problem of solid waste disposal at the city level, but will also allow starting importing garbage from neighbouring regions and countries for further processing. It will undoubtedly contribute to attracting Russian and foreign investments, creating a large the number of jobs and the development of the economy of the region [21].

Another promising area for Khabarovsk and the region as a whole is the introduction of a solid waste separation system. Of course, this requires a revision of the existing system for the collection and recycling of garbage, the creation of collection and sorting stations for solid waste, as well as educational work with the population.

The urban analysis carried out, including the study of natural conditions, the ecological situation, the state of the road network, the nature of the use of urban areas and the economic development base of the city, made it possible to develop a number of proposals for creating a network of enterprises for the processing and disposal of solid waste in Khabarovsk. In accordance with the current master plan of the city [22], the territories most suitable for the placement of waste recycling plants directly on the territory of the city and in its vicinity, as well as the territory of landfills requiring reclamation, have been identified.

We propose the creation of the following objects:

1) Waste recycling enterprises fourth and third generations. The resolution of this group of enterprises is expected in the Industrial district at two sites. The first one is located near the CHPP-1 will allow recycling waste CHP. The presence in the area developed road and rail infrastructure will allow delivering debris from other areas of the city. The use of technology in the apportionment of electricity thru the burning of solid waste will solve the problem of electrification of CHPP-1.

The second site is located between the shoreline of the Ussuri River and the territory of the Regional center of hockey "Amur". In this place, we propose the creation of enterprises for processing of solid waste imported from other settlements of Khabarovsk territory and neighbouring China. Unaffected access to the area will allow equipping the berths for the reception of barges and other river transport that will enable the smooth importation and unloading of solid waste. The construction of such events in the Khabarovsk region will help to attract additional funds to the regional budget, and the use of modern environmentally safe technologies will allow using the territory of the enterprise on the example of the Danish Copenhill and recreational purposes.

2) The Enterprise's Class II. Sanitary-protective zone of such enterprises in the processing of MSW to 40 thousand tons per year is 500 m. This rule is an average and does not take into account modern technical equipment of the enterprise. In some cases, based on chemical examination of the sanitary area can be reduced to 50 m. the Objects in this group offers to place in all districts of the city, in close

proximity to residential areas. This arrangement will reduce the cost of transportation of waste, but also create new jobs for the residents of these neighbourhoods.

3) The Enterprise's Class I. Sanitary-protective zone of such enterprises in the processing of MSW to 40 thousand tons per year is 1000 m. The location of the enterprises in this group is proposed at a distance of 2.5 km Southeast of Krasnorechenskoye village in the administrative district road Ussuri. With this arrangement, the waste recycling company will be able to serve the next cottage settlements, and on the administrative track, it will be possible to organize the delivery of garbage from the localities of Primorsky Territory.

4) Enterprises combining the production function with the recreational, organizational and educational and tourist functions. The construction of such production facility in the city of Khabarovsk will allow showing people how important it is to sort garbage and observation to give a clean because it is possible to see the whole process from the inside. The placing of the enterprises of this group is planned for the "green" areas in the city. The most suitable sites are sites free from building on Industrialnaya and Viborgskaya streets. This arrangement will allow showing residents how the modern enterprise can coexist with nature.

5) Monofunctional enterprises. Narrow-venture for sorting or processing of solid waste is planned to accommodate mainly in the countryside, as their functionality will include the processing of waste from neighbouring regions. For this approach from building sites with flat terrain near the Fedorovka village is free.

6) New enterprises near existing WRSs. The construction of new waste treatment facilities will allow increasing efficiency of working stations and gradually transfer them to new, more environmentally friendly format. The availability of infrastructure will significantly reduce the costs associated with the construction and maintenance of new facilities.

7) Recreational spaces at the site of the former landfill. The analysis made it possible to identify the territory most suitable for placing objects of this type. It is planned to create a park zone in a territory free of development near the Khor village. Currently, one of the unauthorized landfills is located on it. Its liquidation will allow land reclamation and the creation of a modern recreational space, following the example of the Freshkills Park in New York.

5. Conclusion

Preservation and improvement of the ecology of Khabarovsk Territory and the city of Khabarovsk are closely related to the solution of the problem of collection and disposal of solid waste. Currently operating waste processing enterprises using the method of waste disposal are not only useless enough from an economic point of view, but also cause significant harm to the environment. To solve this problem, one should turn to the experience of foreign countries that have similar problems and climatic conditions. However, for many years they have been developing modern technologies in the field of waste collection, disposal and recycling. This problem has very real prospects for solving, especially in connection with the actualization of the development of the Far East in recent years.

References

- [1] Jennifer R Stokes and Arpad Horvath 2010 *Environ. Res. Lett.* **5** 014015
- [2] Sidorkina N M 2016 Construction of the waste processing plant - a breakthrough to improve the environmental environment of Volgodonsk *Science today: postulates of the past and modern theories: materials of the IV International Scientific and Practical Conference (October 13, 2016)* (Saratov: Academy of Business)
- [3] Popov D V 2018 Typology of modern waste incinerators (MSW) *Architecton: Proceedings of Higher Education* **3** (63), available at: http://archvuz.ru/2018_3/9
- [4] Popov D V 2019 Principles of form-building for contemporary waste incineration plants *Architecton: Proceedings of Higher Education* **3** (67), available at: http://archvuz.ru/2019_3/6
- [5] Yalovaya N P, Trifonova N G and Yalovoy P S 2017 Use of processed organic waste in the

- “green” improvement of urbanized territories *Bulletin of the Brest State Technical University* **2** 130–5
- [6] Sazykina E V 2016 Architecture of modern utility industrial objects of the urban environment on the example of waste processing plants and waste water treatment stations *Architecture and Modern Information Technologies* **2** (35), available at: marhi.ru/AMIT/2016/2kvart16/saz/abstract.php
- [7] Filatov V V, Rukina I M and Golovanov V I 2018 Innovative technologies for the recycling of production and consumption wastes: the experience of Russia and foreign countries *Scientific information-analytical magazine “Municipal Academy”* **2** 137–144
- [8] Tatyana Orlova et al 2017 *IOP Conf. Ser.: Earth Environ. Sci.* **90** 012110
- [9] H Luo et al 2018 *IOP Conf. Ser.: Earth Environ. Sci.* **186** 012060
- [10] Temelis N J 2007 Waste and coal power plants: whose emissions are cleaner? *MSW* **6** 52–6
- [11] Interactive map of landfills *General cleaning*, available at: <https://kartasvalok.ru>
- [12] Intercom 2019 Ecological rating of 200 cities of Russia for 2019, available at: https://www.domofond.ru/statya/ekologicheskiy_reyting_200_gorodov_rossii_za_2019_god/100219
- [13] How to sort and recycle garbage in Japan *Recycle*, available at: <https://recyclemag.ru/article/kak-sortiruyut-i-pererabatyivayut-musor-v-yaponii17-22>
- [14] How to sort and recycle garbage in China *Recycle*, available at: <https://recyclemag.ru/article/kak-sortirujut-i-pererabatyivayut-musor-v-kitae>
- [15] How to sort and recycle garbage in South Korea? *Yvision*, available at: <https://yvision.kz/post/753766>
- [16] Project of the Tecart Consulting Group in the field of clean technologies. Westinghouse Plasma Corporation Plasma Gasification Technology *Cleandex*, available at: http://www.cleandex.ru/articles/2016/03/07/zavody_po_pererabotke_othodov_proizvodstva_i_potrebleniya_v_elektroenergiyu
- [17] Japan's experience in waste management. Development and implementation of gasification and ash melting technology of Mitsubishi company *MHI Group Mitsubishi Heavy Industries*, available at: <https://www.spbinitiative.ru/en/presentations/mitsubishi.pdf>
- [18] On the roof of the Copenhill power station in Copenhagen opened a ski run *BuildingTech*, available at: <https://building-tech.org/na-kryshe-elektrostantsii-copenhill-v-kopengagene-otkryli-lyzhnuju-trassu/>
- [19] RSHA What to do with garbage in Russia? *Greenpeace*, available at: <https://www.greenpeace.org/russia/Global/russia/report/toxics/recycle/RUSSIA-GARBAGE.pdf94>
- [20] Standards for the accumulation of municipal solid waste: dimensions, calculation, use *Ministry of Housing and Public Utilities of the Khabarovsk Territory, official website*, available at: <http://gkh27.ru/about/info/news/2411/>
- [21] Volkova A V 2018 Waste recycling market National Research University Higher School of Economics *Development Center*, available at: [https://dcenter.hse.ru/data/2018/07/11/1151608260/Market% 20 of utilization% 20 of waste% 202018.pdf](https://dcenter.hse.ru/data/2018/07/11/1151608260/Market%20of%20utilization%20of%20waste%202018.pdf)
- [22] The current master plan of the city of Khabarovsk *Portal of the administration of the city of Khabarovsk*, available at: https://dasiz.khabarovskadm.ru/town-planning/gen_plan/