IFC Advisory Services in Europe and Central Asia
Resource Efficiency Program

WASTE IN RUSSIA: GARBAGE OR VALUABLE RESOURCE?

SCENARIOS FOR DEVELOPING THE MUNICIPAL SOLID WASTE MANAGEMENT SECTOR

In partnership with

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Final report

Extended edition

Acknowledgments

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[1] The list displayed in an alphabetical order. Job title and employer are current as of the time the report was prepared.

Acronyms and Abbreviations

EPR	— extended producer responsibility
EU	— European Union
EU-12	— countries that joined the EU after 30 April 2004
EU-15	— countries that joined the EU before 30 April 2004
EU-27	— all the EU member countries before 1 July 2013
Eurostat	— Statistical Office of the European Union
FL	— federal law
GDP	— gross domestic product
GNI	— gross national income
GRP	— gross regional product
IFC	— International Finance Corporation
kWh	— kilowatt-hour
MSW	— municipal solid waste
MW	— megawatt
PPP	— public-private partnership
RF	— Russian Federation
RF Rosstat	— Russian Federation Federal Service for State Statistics

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In 2010, Russia produced more than 48 million metric tons of municipal solid waste. About 95 percent of that amount was sent to landfills.

Currently, up to 30 percent of landfills do not meet sanitary requirements, and the potential for expanding the landfills is severely limited.

Introduction

Every year, Russia generates 55-60 million tons of municipal solid waste (MSW) [1] with a per capita average reaching up to 400 kg per year. Furthermore, the per capita figures largely differ in terms of urban and rural areas.

The amount of MSW in Russia is growing and will continue to increase as living standards rise, reflecting an existing correlation between the GDP per capita dynamics and waste generation. Unless measures are taken to respond to this situation, a continuation of business as usual in the MSW sector may lead to serious environmental consequences.

Only 5-7 percent of MSW in the country is being recycled, which means that more than 90 percent of refuse in Russia is sent to landfills and unauthorized dumps, and the amount of accumulated waste is rising. On the other hand, in European Union countries as much as 60 percent of MSW is recycled.

The deteriorating waste collection and disposal infrastructure must absorb a growing amount of un-recycled waste, but landfills and dump sites are not properly equipped to protect soil, groundwater and areas near landfills and dumps.

Waste disposal user fees in Russia do not reflect the real cost of managing waste. Comparatively low fees hinder the development of a sustainable municipal solid waste system, including the development of new waste recycling and processing projects. However this report does not analyze the level of waste user fees, nor does it make any specific related recommendations.

More than 14,700 authorized waste disposal sites occupy about four million hectares [2], which is comparable to the area of Switzerland and the Netherlands combined. And each year, 400,000 hectares of land, 40 percent more than the area of Luxembourg, are allocated as disposal sites for the ever-increasing quantity of MSW.

In addition to absorbing large land resources, landfills contaminate the atmosphere, topsoil, groundwater and subsoil, causing negative effects on wildlife and people's health and quality of life in areas near landfills and dumps. And since there is no comprehensive system to collect and process waste that contains toxic components, environmental pollution by hazardous substances is increasing.

The practice of discarding un-recycled MSW in landfills results in the irretrievable loss of valuable materials (such as paper, glass, metals and plastic) and missed opportunities to use MSW as an alternative fuel. According to estimates by a number of experts, these materials account for more than 40 percent of MSW or 15 million tons annually.

Since there is no possibility to recycle some of the waste components (even recyclable paper and cardboard for a minimum fee), the estimated annual forgone benefit is at least 68 billion RUB (€1.7 billion). Moreover, MSW could be used as an alternative fuel in the cement industry and at incineration plants.

The government and society are united in the opinion that the waste management sector requires systemic reforms in order to mitigate environmental stresses and increase resource efficiency. Environ-

mentally sustainable economic growth plus the preservation of biodiversity and natural resources were proclaimed as priorities in the "Principles of Government Environmental Policy in the RF for the Period up to 2030".

Regarding MSW, it is recommend creating a system for collecting different types of waste, imposing strict sanctions for the improper dumping of waste and phasing in a ban on the disposal of recyclable waste. This last measure was reflected in some amendments to the federal law "On the Production and Consumption of Waste," which are currently being evaluated in a second legislative reading.

The new edition of the law introduces the concept of extended producer responsibility (EPR) and an economic mechanism for implementing it.

The Comprehensive MSW Management Strategy prepared by the Russian Ministry of Natural Resources and the Environment is currently under discussion along with an action plan to properly implement it. The RF State Program "Environmental Protection for 2012-2020" recently declared that generated waste of all types should be reduced by a factor of 1.6 in per capita terms, as compared with 2007.

As ordered by the President of the Russian Federation, every constituent entity of the Russian Federation was required to prepare a regional waste management program with specific MSW recovery targets by November 1, 2011. The agencies preparing the programs encountered a host of difficulties that were primarily caused by a lack of experience in providing a solid basis for setting attainable performance targets, a lack of knowledge about how to attract investments and a lack of accessible and reliable information on the best available MSW recycling technologies. As a result of insufficient funding,
many elements of the programs are not being implemented.

While studying the MSW market in Russia, IFC focused on developing practical recommendations and benchmarks for the strategic, sustainable development of the MSW management sector at the federal and regional levels in Russia. The recommendations were developed in order to maximize technical and financial efficiencies as well as implementation periods.

The purpose of this study is to demonstrate the potential of the waste-recycling sector in Russia and to offer recommendations for how it should be developed. The authors base their forecasts and guidelines on an analysis of the MSW sector outside of Russia and by modeling various MSW management development scenarios. The study considers the institutional and economic mechanisms that would help fully realize the waste recycling potential in the most efficient manner.

The methodology of this study is based on the following approaches and principles:

- Conduct an analysis of the MSW sector in similar countries followed by applying conclusions that have been verified by a correlation analysis to the Russian market;
- Adjust for specific regional characteristics with the use of a cluster analysis;
- Consider the short-term and long-term aspects of development and implementation;
- Use the best technologies and practices in the industry;
- Review existing legal, institutional and economic conditions and provide recommendations for ensuring that established performance targets are achieved.

This report is designed to assist federal and regional government agencies that make policies and administer MSW management facilities within their jurisdictions, as well as entities that can submit legislative initiatives aimed at improving the functioning and development of the MSW management sector in Russia. This report is also of interest to potential investors and private companies planning to enter the waste management sector in Russia.

Structure: This report consists of three chapters: an introduction, conclusions and recommendations. There are also two appendices.

Chapter 1 analyzes the state of waste management in Russia and in Europe, defines development trends and draws parallels between the current state of affairs in Russia and in select European countries 10 to 15 years ago.

Chapter 2 assesses the potential of the MSW management sector in Russia and considers two scenarios for how it may develop by 2025 – a business-as-usual scenario and an innovation scenario. The analysis is based on applying the European experience and adjusting it to compensate for regional differences that arise, when the constituent entities of the Russian Federation are combined into clusters.

Chapter 3 outlines recommended legislative, institutional and economic changes that are needed for the innovative development of the MSW sector. Chapter 3 also describes specific actions for the federal and regional implementations and assesses the socioeconomic importance of developing MSW recycling.

This report employs terminology this is commonly used internationally. The terms and definitions are provided in Appendix 1. Appendix 2 contains a description of the most frequently used waste management technologies at various stages of the waste life cycle.

The methodology and findings from the study may be used while:

- Setting performance targets for the development of the MSW management sector at the federal and regional levels;
- Drawing up an action plan (roadmaps) for the implementation of national and regional MSW strategies;
- Identifying potential financial instruments for MSW projects;
- Selecting optimal technological and process solutions.

The current amount of accumulated waste in Russia is enough to fully load the Trans-Siberian Railroad for the next 2,400 years.

The creation of an advanced MSW management system in Russia will require capital investments in an amount that exceeds the investments in fixed assets currently being allocated to the transport and communication sectors.

Chapter 1: Summary and Conclusions

Chapter 1 examines:

- The quantitative and qualitative characteristics of MSW generation in Russia compared to other countries;
- Trends and established MSW management practices in Russia;
- Environmental and economic impacts of the current MSW sector;
- The current regulatory frame, MSW fees & the payment system;
- The MSW management experience of the initial EU members (the EU-15) and the new members (Central and Eastern Europe countries, namely the EU-12).

An analysis of MSW generation and management in Russia and abroad leads to a number of conclusions:

1. Despite representing a small share of the total volume of waste that is generated in Russia, municipal solid waste has a substantial impact on human health and the environment.
2. The quantitative and qualitative characteristics of MSW generation in Russia differ, for now, from developed countries (the EU), but the gap is rapidly narrowing.
3. The amount of MSW generation is trending upward.
4. The federal and regional authorities recognize the need to manage MSW more effectively, but the measures being taken are not enough to deliver positive change.
5. The main barriers to improving the MSW management system are: an unregulated system of waste ownership and distribution of responsibility, insufficient participation by the private sector, a lack of transparency in the industry, an ambiguous pricing policy and an absence of economic incentives for recycling MSW.
6. The state of MSW in Russia is in many ways similar to that in the EU-12 countries before comprehensive MSW strategies were implemented there.
7. In the next 10 to 15 years it is possible for Russia to make a transition from disposing most of its waste to recycling a substantial amount of its waste.
8. A number of proven European administrative and pricing models can be successfully applied in Russia with adjustments made for regional peculiarities. This is especially the case regarding an implementation of the EPR principle, the coordinating agent model and a framework for implementing public-private partnerships (PPPs) in the sector.

Chapter 1
Analysis of the current municipal solid waste management sector in Russia and abroad

1.1. Trends in waste generation and recycling/disposal

The manner in which waste is managed in Russia is having an increasingly negative impact on the environment and human health, and is characterized by the inefficient use of material and energy resources.

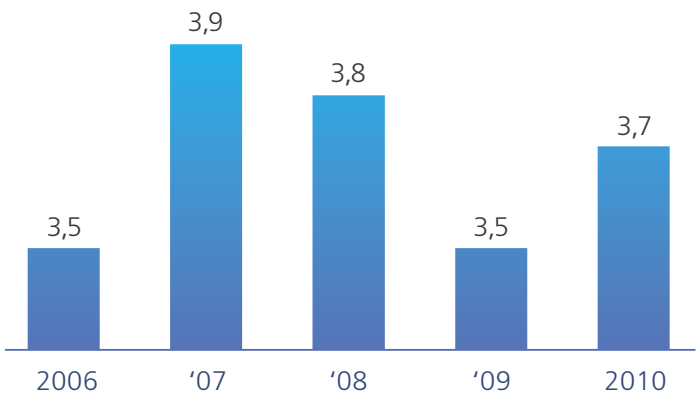
According to the Russian Ministry of Natural Resources and the Environment,[1] three to four billion tons of waste are generated in the country annually. More than half of the waste (54 percent) comes from the extraction of raw materials used to generate energy (mostly by the coal industry).

Also, 17 percent comes from nonferrous metallurgy, 16 percent from the iron and steel industry and 12 percent from other sectors, including housing and utilities. MSW accounts for one to two percent of all waste. According to Rosstat – the Federal State Statistical Service – about 49 million tons of MSW were generated in Russia in 2010.

Despite the fact that MSW represents a small portion of the total waste, the efficient management of MSW is extremely important. This is the case since the management of MSW directly affects the environment in and near residential areas. Furthermore, recycled waste is an additional resource for generating raw materials, supplies and energy for the national economy.

The volume of waste generation correlates with the level of Russia's economic development and living standards. As Figure 1 demonstrates, during the economic downturn in Russia the total volume of waste decreased. Once the economy recovered, waste volumes returned to previous levels. In 2009, the amount of waste declined to 3.5 billion tons; in 2010 it increased to 3.7 billion tons.

Fig. 1 Waste generation in Russia, billions of tons



Source: Government report "On the Condition and Protection of the Environment in the Russian Federation in 2010," p. 280 [3].

[1] Government report "On the Condition and Protection of the Environment in the Russian Federation in 2010," p. 278, http://www.mnr.gov.ru/regulatory/list.php?part=1265

For your information

Fifteen to twenty million tons of organic waste end up in dumps each year, which amounts to 30-40% of organic fertilizers used in the Russian agriculture per year (53 million tons). Composting this organic waste will enable a significant increase in the production of environmentally clean fertilizers [4].

The annual volume of paper and cardboard waste generated per year (about 15 million tons) is almost triple the volume of cellulose produced in Russia (about 6 million tons) [5].

The amount of glass disposed of in landfills in Russia is equivalent to the amount of glass containers produced in Germany (3.1 million tons) [6].

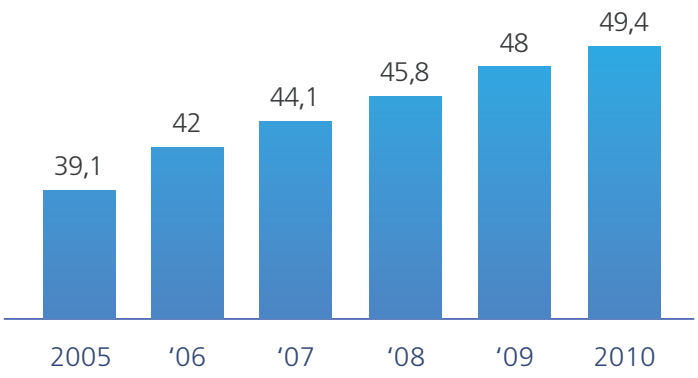
The amount of cardboard and paper that is irretrievably lost when buried in landfills is comparable to the amount of paper and cardboard produced in Finland, one of the leading exporters of such products in the EU (Finland exports 11.3 million tons per year) [7].

The volume of MSW generation is trending upward, despite the decline in population. According to Rosstat, the volume of MSW increased by 26 percent between 2005 and 2010.

The significant growth of MSW is attributable to the increase of waste generated per capita (this increase per capita is otherwise known as waste intensity). In 2000, about 220 kg of MSW per capita were generated and by 2010 this figure had risen to 330 kg. In Russia, rising living standards and household purchasing power brought about an increase in consumption and a change in consumption patterns from 2000 onward. Consumption shifted to more waste-intensive goods and services.[2] Also, an increase in the proportion of nonfood items purchased by consumers generated a larger amount of packaging waste.

Per capita waste generation in Russia is still substantially below the European average (503 kg per person per year), and even lower than in the EC-12 countries (420 kg per person) where the personal income level is similar to that of Russia.

Fig. 2 MSW generation trend, million tons



Source: IFC calculations based on Rosstat data [9].

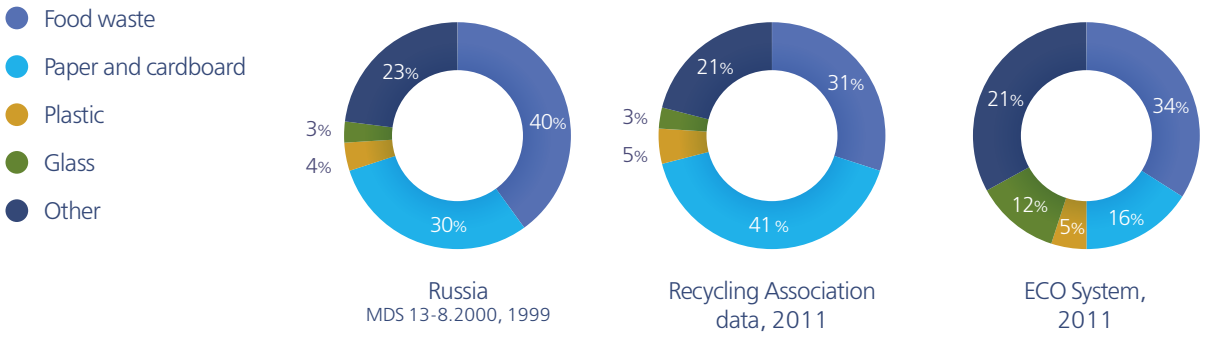
[2] Goods and services with large individual volumes of waste generation.

The composition of waste is a determinant for a waste management system. It is the composition of waste that determines the requirements for the collection and processing system, as well as the optimal configuration of MSW management measures. The importance of this indicator is largely increasing in the selection of MSW recycling patterns

No comprehensive studies of the MSW composition in Russia have been conducted. The only sources of statistical information come from small studies performed by MSW operators and associations for specific regions (at different times). The conclusions of the studies vary. For example, according to the Recycling Association, the paper/cardboard and glass fractions in Russia make up 41 and 3 percent of MSW, respectively, whereas operators report 16 and 12 percent. This disparity could be attributable to the unrepresentative sampling.

Nevertheless, on the basis of this information, it can be concluded that there has been a decline in the share of organic fractions and an increase in their inorganic counterparts (not readily degradable or non-degradable fractions). Inorganic fractions primarily consist of packaging waste (paper, plastic and glass). In 2000, organic waste accounted for 40 percent of MSW (Figure 3).[3] And by 2011, the amount of organic waste had decreased by 6 to 10 percent (data from field studies), while the portion of recyclable fractions had increased. The "other" category of fractions includes hazardous waste and bulk garbage, electronic merchandise, whose service life has ended, and other less important types of waste.

Fig. 3 Expert assessment of MSW's contents in Russia



As Figure 3 demonstrates, the share of organic material as a percentage of MSW in Russia is gradually declining. Nonetheless, it is still substantially higher than in Northern and Western Europe. Additionally, the share of plastic and glass is relatively small. Today, the composition of MSW in Russia is most similar to that in the Eastern European countries such as Poland, the Czech Republic, Slovakia and the Baltic states.

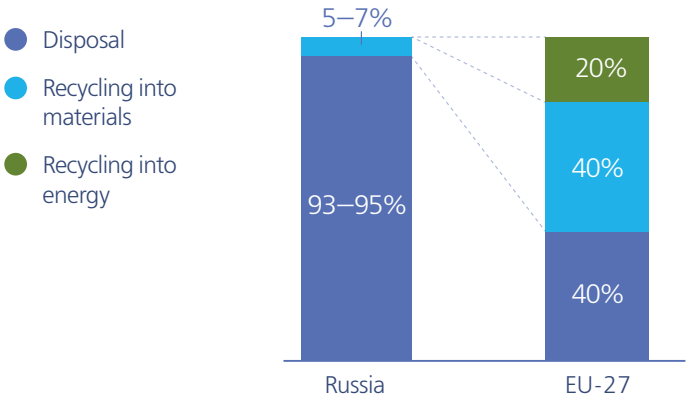
Despite the large portion of recyclable fractions available in Russia's MSW, the recycling level, by the most optimistic estimates, is no more than 5 to 7 percent (Figure 4). The rest of MSW is discarded.

Russia has seven incineration plants, five waste recycling plants and 39 waste sorting complexes.[4] The primary recycling method for recycling waste is sorting with the extraction of secondary raw materials.

[3] MDS 13-8.2000 "Strategy for Household Solid Waste Management in the Russian Federation."
[4] Data from Rosprirodnadzor, 2010.

The average productivity of all waste sorting facilities in Russia is about 180,000 tons per year, which is comparable to the amount of waste generated in small cities. Waste sorting complexes operate in Togliatti, Belgorod, Moscow, St. Petersburg, Voronezh, Ufa, Arkhangelsk, Maloyaroslavets, Almetyevsk, Barnaul and some other cities.

Fig. 4 Comparison of MSW recycling levels



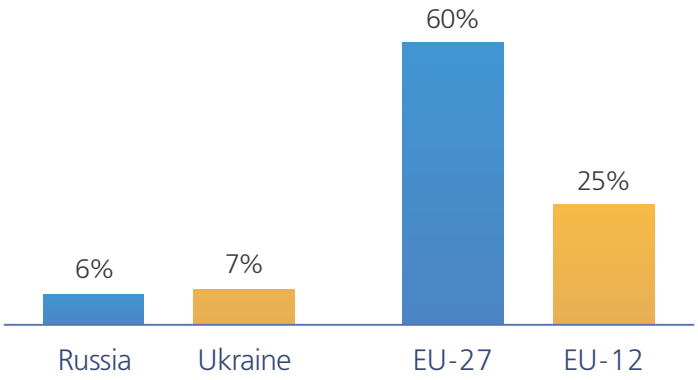
Source: IFC[5], Eurostat data [12].

The EU-27 countries recycle an average of 60 percent of their waste (see Figure 5), while the United States recycles more than 40 percent. In Russia, most waste is sent for disposal, while less than 50 percent is recycled and decontaminated (46.5 percent in 2010).[6]

According to the Russian Federation Ministry of Natural Resources and the Environment,[7] as of the beginning of 2011 landfills had accumulated more than 32 billion tons of waste of all types, including industrial, agricultural and municipal (according to other estimates, about 60 to 70 billion tons[8]).

Furthermore, municipal waste disposal sites account for more than 50 percent of all waste disposal sites in the country and no more than 8 percent meet requirements for the sustainable treatment of MSW. Figure 5 shows the rates of MSW recycling in Russia, Ukraine and the EU countries.

Fig. 5 Comparison of MSW recycling rates



Source: IFC, Rosstat data [9]; data from the Ukrainian State Statistics Service [10]; Eurostat data [11].

[5] Here and elsewhere in the text — data from the Report "Ecorem Plc. Study on Industrial and municipal waste in Russia and Ukraine," 2011, prepared for IFC, calculations of IFC.
[6] Russian Federation Federal Service for State Statistics. Use and decontamination of industrial and consumer waste by economic activities in the Russian Federation. — 2012 [13].
[7] Government report "On the Condition and Protection of the Environment in the Russian Federation in 2010," 2012. P. 280 [14].
[8] Izvestia.ru. Russia accumulated more than 80 billion tons of waste. 2009, 18 March [15].

According to Rosprirodnadzor (the Federal Service for the Supervision of Natural Resource Use), as of 2010 there were 7,518 waste disposal sites in Russia consisting of:

- 1,699 MSW landfills;
- 576 industrial waste disposal sites;
- 5,243 unauthorized dumps.

The accumulation of waste in landfills and dumps contributes to air pollution, contaminates soil, groundwater and surface water, disrupts ecosystems and hampers the agricultural and construction industries (since land is removed from the economic circulation). In addition, landfill gas emissions adversely impact the climate.

The present waste management system practices in Russia do not provide the economic benefits of reusing recoverable resources and reducing harm to the environment. The majority of landfills are obsolete and in ill repair and will not be able to accommodate the growing volume of waste that is expected in the future.

Operating the MSW disposal infrastructure using both the current methods and existing infrastructure will ultimately lead to serious environmental consequences that pose a hazard to the Russian Federation's well-being.

1.2. Analysis of legislative and institutional fundamentals of waste management in the Russian Federation

Compliance with legal requirements and initiatives

The management of municipal and industrial solid waste is regulated by Federal Law No. 89-FZ of 24 June 1998 "On the Production and Consumption Waste" (as further revised and amended). This law defines the general requirements for waste management, including the responsibilities of the Russian Federation, constituent entities of the RF and local government authorities, standards, government record keeping and reporting, economic regulation and monitoring, and liabilities regarding waste management.

The law was preceded by the adoption of an earmarked federal waste program,[9] whose purpose was to "create a regulatory and technological framework to conduct a unified government policy regarding waste management at every administrative level," as well as to:

- devise new technologies and organize activities for the recycling and decontamination of municipal and industrial waste;
- implement pilot projects and programs using the new technologies;[10]
- set up the recycling and decontamination of accumulated waste.

Up to 80 percent of the program's costs were expected to be covered by budgetary funds, while the other 20 percent would come from profits generated from the sale of secondary raw materials and supplies. Unfortunately, for a number of reasons, including the insufficient funding of the program as a whole, the program's stated objectives were not achieved.

[9] Resolution No. 1098 of the Russian Federation Government of 13 September 1996 "On the Special Federal Waste Program."
[10] Federal Service on Hydrometeorology and Environmental Monitoring. Climate Change Action Plan Report, 1999 [16].

The Interagency Committee to Improve State Regulation of Waste Management has been active since 2008. In 2010-2011, the committee submitted a number of proposals to modifications the federal law.

Amendments to the Federal Law "On the Production and Consumption Waste" are currently being considered in their second reading in the Federation Council. The main proposed changes introduce extended producer responsibility (EPR) for the production of waste and bring in economic incentives for entities and entrepreneurs engaged in minimizing and recycling waste.

The waste management section of the "Principles of State Environmental Policy in the RF for the Period up to 2030" provides for the segregated collection of different types of waste, strict sanctions for improper disposal and a phased-in ban on the disposal of recyclable waste. A number of regions have developed waste management strategies for achieving target levels of recycling and mitigating environmental harm.

Additionally, strategies have been developed to use the best available technologies for MSW management. The cost of these programs ranges from €20 million to €100 million. All of the strategies envisage primarily non-budgetary funding.

By Russian Federation Presidential Order No. Pr-781 of 29 March 2011 leaders of the top executive governmental agencies of the constituent entities of the Russian Federation were instructed to arrange for the preparation of long-term special investment programs for municipal and industrial solid waste management by 1 November 2011. The programs should be based on an integrated approach to the collection and recycling of all waste types. Most regions treated this matter in a pro-forma fashion, since a procedure for drawing up such programs on the basis of best international practices had not yet been set up and since the previous format for preparing earmarked programs had been perfunctory in nature.

Presidential Order No. Pr-2138 of 12 August 2012 instructed the Russian Government to formulate a comprehensive MSW management strategy by 1 February 2013 that would provide for, among other things, the creation of an efficient administration system. And by 1 January 2013, the government was to prepare revisions of the MSW management legislation establishing recycling as a priority over

Example of a regional MSW management strategy: the Samara Region

The Samara Region generates about 1.3 million tons of MSW per year, most of which is disposed of in landfills. About 17% of municipal waste is recycled at a plant in the city of Togliatti.

Under the regional program that was adopted,[1] the garbage collection infrastructure will have covered 100% of the Samara region by 2020. The region will have 26 operating landfills and the amount of waste that is recycled will reach 33%. To achieve these goals, modernization of waste collection equipment will be carried out and some municipalities will begin collecting garbage that is pre-sorted.

The plan is to create 23 new landfills most of which will have stations for the preliminary sorting and storage of waste. The sorting operation will remove hazardous waste and manually extract paper and plastic. It is also planned to erect sorting and recycling facilities at three large landfills. In addition to the construction of new facilities, existing ones which don't comply with sanitary requirements will be closed.

Funding for the program is 2.8 billion RUB, which will be allocated from budget sources.

[1] Resolution No. 372 of the Samara Region Government of 6 August 2009 "On the Approval of Samara region state program [17]

disposal, and redistribute MSW management authorities among municipalities and the constituent entities of the Russian Federation. The draft strategy is under discussion and approval.

Ownership and administration of MSW

Regional and local administrations are responsible for implementing technologies for recycling and minimizing municipal waste. A number of fundamental powers and obligations related to MSW management have been established by the Russian law. The distribution of obligations among market participants is given in Table 1.

Table 1. Distribution of functions among participants in the waste management cycle

Function	Participant
Direct ownership of waste. Obligation to prevent environmental harm	The public, organizations, entrepreneurs
The right to profit by disposing of assets and transferring ownership. The obligation to pay compensation for negative effects on the environment	Organizations, entrepreneurs
Organizing the collection and removal of garbage from a community	Municipality
Organizing the disposal of waste	Constituent entity of the Russian Federation
Proper operation of MSW facilities and delivering waste collection and processing services for a specified fee	Specialized organizations authorized by contracts
Licensing and monitoring the delivery of services, evaluation of the technical, sanitary and environmental safety of existing facilities and those under construction	Regional representative offices of the federal agencies: Rostekhnadzor, Rosprirodnadzor and Rospotrebnadzor

Sources: Federal Law No. 89-FZ of 24 June 1998 "On the Production and Consumption Waste," Federal Law No. 126-FZ of 25 September 1997 "On the Financial Fundamentals of Local Self-Government in the Russian Federation," Federal Law No. 7-FZ of 10 January 2002 "On Environmental Protection."

Examples of projects and programs to be implemented in Russia

Kostroma

At present, a dump located 3 km from the city of Kostroma receives 65,000 tons of unprocessed MSW per year. A 10-year, €21 million program has been conceived to upgrade this facility, which includes enhancing the waste collection infrastructure (€1.5 million) and constructing a sanitary landfill (€5.9 million) with facilities for pre-sorting and recycling a mixed waste stream (€13.5 million). Up to 15,000 tons of waste are expected to be recycled annually into secondary materials.

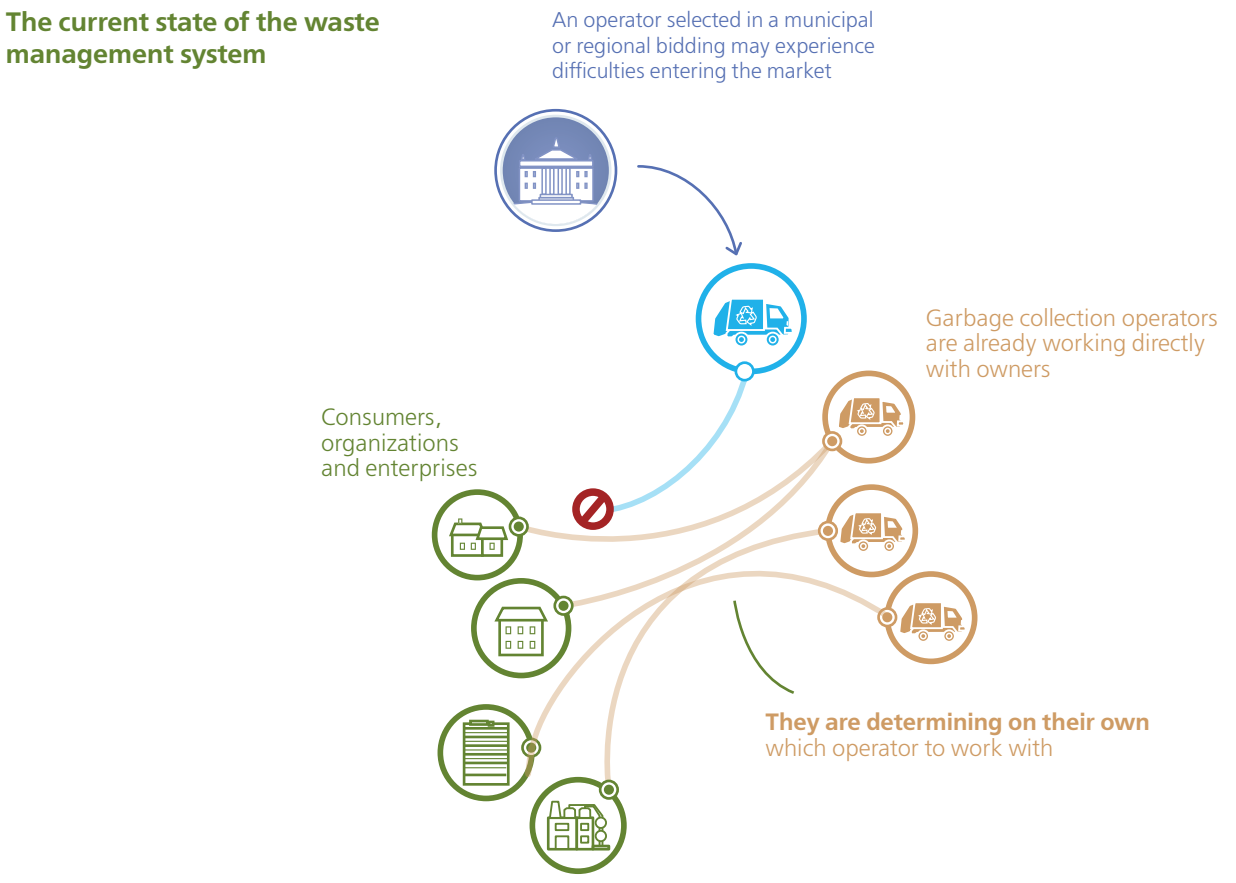
Stary Oskol / Gubkin

These neighboring towns generate more than 80,000 tons of MSW per year. Currently, all of the waste goes to urban dumps. The construction of a regional waste management system is planned for within 10 years at a cost of €25 million. The system will consist of a common sanitary landfill (€5.6 million) with a mixed waste stream sorting facility (€17.5 million). Up to 22% of the waste is expected to be recycled into secondary materials every year. The basic waste collection infrastructure is set for an upgrade within seven years (€2 million).

Source: IFC.

As Table 1 shows, there is a division between waste ownership and the obligation to organize waste management. With regard to the organization of operations at the subnational level, the relationships of market participants are depicted in Figure 6.

Fig. 6 Waste market structure



Source: IFC.

The fact that those owning waste are not responsible for organizing waste management and those responsible for organizing waste management cannot assume ownership of waste has a number of negative consequences:

- There is a lack of interest on the part of small companies to work in challenging sectors of the economy and there is a pricing pressure on local administrations;
- There is a risk that companies will establish monopolies (a local administration could make an effort to control the entire system of services) along with an ineffective fee and budgetary policy;
- Companies that have the necessary technological and financial capabilities to resolve waste management problems have limited access to the market.

As a result, municipalities may make faulty decisions leading to inadequate services for citizens and environmental harm. Additionally, recycling could end up being expensive for both consumers and the administration.

The current law requires that entrepreneurs and business entities own the waste that they generate. This is an important prerequisite for awarding them the benefits that may be obtained from recycling waste into secondary raw materials.

Meanwhile, municipalities are responsible for organizing the collection and transport of waste. The determination of disposal site locations and how these sites should be developed are entrusted to administrative bodies of the federation's constituent entities. In practice, the local authorities often require consumers to enter into waste transport contracts with specialized municipal enterprises. This is the case for both management companies in the residential sector and individual homeowners. Sometimes, contractors are selected in a competitive bidding to determine which operator will serve an urban area.

The current state of affairs means that:

- Operators that wish to work in a particular region must make a contract with each consumer, of whom there may be several thousands;
- Consumers are free to enter into a contract with any entity (regardless of whom the municipality chose) and this entity is unlikely to have full control of all waste streams in the area;
- Conflicts may arise between operators regarding the right to access landfills that fall under the authority of a regional administration. If an operator plans to engage in collection, removal and disposal, it must coordinate such intentions with the authorities of the federation's constituent entity.

Companies that wish to transport or receive certain amounts of waste for recycling must establish individual contracts with a multitude of different consumers, risking the ability to retain agreements for the long term.

In a sector where the scale and continuity of the production process are crucial, the absence of a guaranteed waste stream and uncertainty in the choice of contract counterparts make it difficult to raise private capital.

Government authorities at all levels acknowledge that the waste management system in its current shape is not capable of providing effective services.

Creating economic incentives and a funding mechanism for developing a waste recycling system

Household and enterprise waste disposal fees are the main source of funding for the MSW sector in Russia. The overall expense for consumers consists of collection, transport and waste disposal fees. As is the case with utility services, pricing, as a rule, is based on the cost-plus principle for each specific user of a disposal facility.

Fees for specific households have long been calculated according to the square footage of dwellings where consumers are registered. The provisioning of services is also determined by square footage. This approach may be compared to paying for electricity without a meter, which does not give consumers an incentive to use the service in a sensible way.

The main reason this situation exists is because of the longstanding notion of waste removal as a kind of a public utility function in which waste is meant to be collected and removed from communities. This function is referred to as "clean-up" in the Law on Production and Consumption of Waste.

In short, negative consequences for the environment, human health or the economy (economic losses based on forgone benefits from the failure to use recycled resources) are not accounted for in the existing system.

This is evident in the wide disparity between regional fees and the rates of waste accumulation that are the basis for determining the fees. The latter are often not set out using objective factors.

The development of recycling is perceived as a public good that should be handled by a third party and preferably without the financial participation of residents. Thus, people do not agree with the concept that paying for a valuable service is an opportunity to preserve a healthy environment. Also, in different regions the practice of recording the volume and weight of waste varies, adding additional uncertainty.

The current structure of fees and payments is shown in Figure 7.

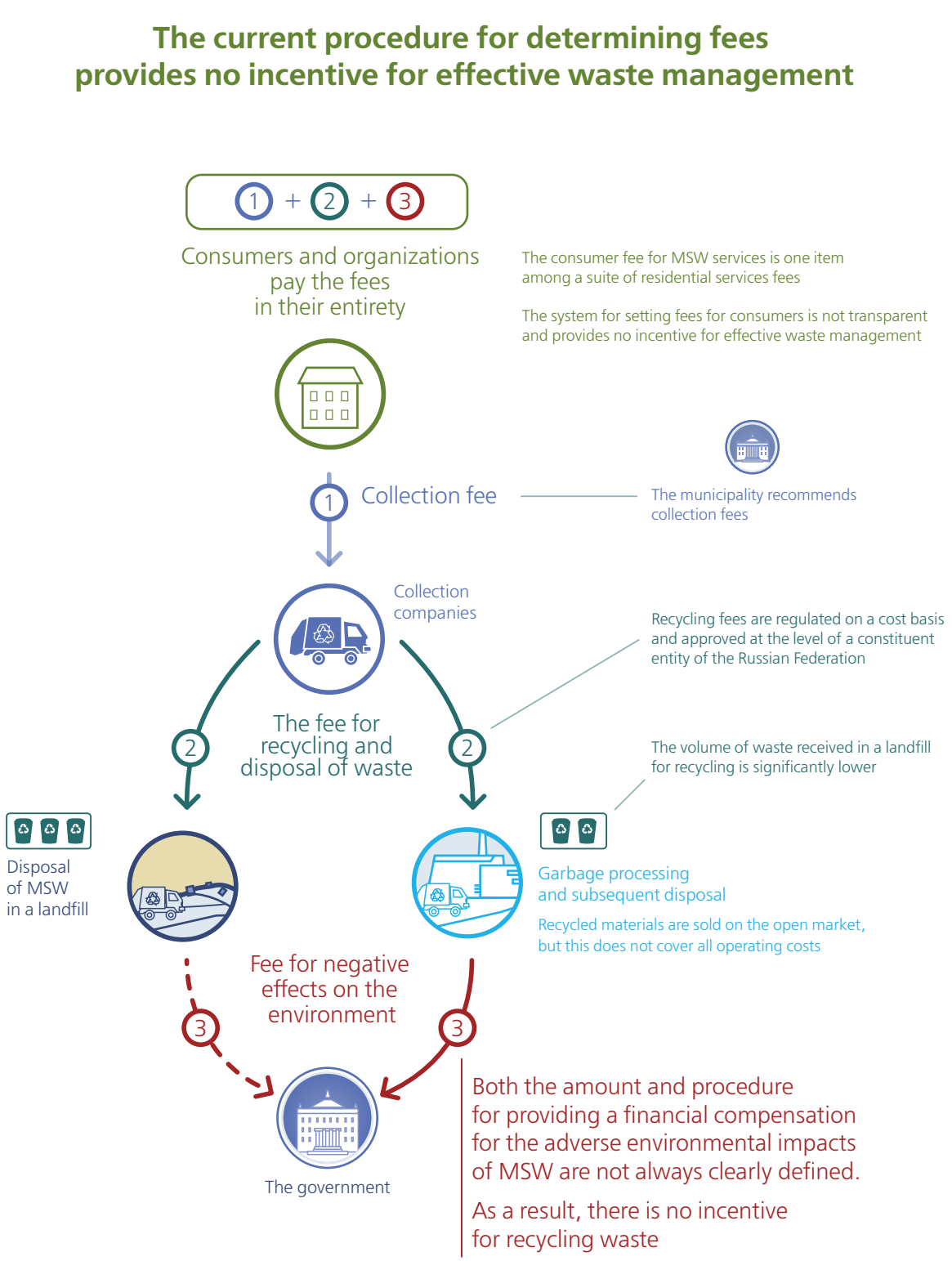
Fees may vary widely even within a single region: the Samara Region case

The rate, at which MSW accumulates, as well as the fees for MSW, varies widely among communities in the Samara Region.

The accumulation limit in Bezenchuk is 0.03 m^3 per person per month, while in other communities it is several times higher. For example, in Chapaevsk the limit is 0.12 m^3 per person per month, while in Syzran and Otradny the limits are 0.17 m^3 and 0.12 m^3, respectively. This explains the substantial differences in fees. For example, while the average fee for the Samara region is 48.5 RUB, the one in Bezenchuk is only 14.3 RUB.

Source: Yu. V. Strogankov. "The Garbage Problem in Bezenchuk and Ways of Solving It." [18].

Fig. 7 Determination of fees for MSW transportation and decontamination services



Sources: Federal Law No. 210-FZ of 30 December 2004 "On the Fundamentals of Regulation of Fees for Utility Companies," Federal Law No. 89-FZ of 24 June 1998 "On the Production and Consumption Waste," Federal Law No. 126-FZ of 25 September 1997 "On the Financial Fundamentals of Local Self-Government in the Russian Federation," Federal Law No. 7-FZ of 10 January 2002 "On Environmental Protection," IFC.

The current practices result in two main issues:

1. The fees are not transparent to the consumer, since they are often not tied to the actual volume of waste and vary disproportionately to the amount of services provided;
2. The fees are insufficient for operators, since they frequently do not cover the costs of maintaining an environmentally friendly infrastructure.

In sum, the economic incentives for encouraging the recycling of waste are inadequate. Despite the fact that laws prescribe reduced waste disposal payments and an accelerated depreciation of fixed assets for entities that introduce recycling and low-waste technologies,[11] regulations for these measures have often not been worked out in detail at the regional level.

As a result, the cost of recycling is passed along in its entirety to the consumers in the form of a regulated fee, which may be more expensive than the cost of disposing waste in a landfill, since recycling adds additional expenses. The relatively low cost of disposal creates distorted incentives for operators and local authorities, when choosing between waste disposal and recycling.

Attracting private investments through public-private partnerships

The importance of using PPP mechanisms to implement large infrastructure projects and programs has been increasingly recognized over the past several years in Russia. Commercial cooperation between governmental authorities (federal, regional and local) and private companies is already underway in a whole host of areas such as housing, utilities, transportation and sports infrastructure.

In each case the private partner in a PPP, under a set of specified terms, receives state-owned assets for commercial use (or uses them to create new assets), while sharing the financial, technological and operational risks of administration.

In fact, using PPP mechanisms for waste management is an appropriate solution given the history of the MSW market:

The waste management infrastructure is state-owned and privatization is often not a viable alternative in light of the sector's social significance;

Municipal MSW operators do not have sufficient capabilities (technological, financial, etc.) or incentives to modernize and build new infrastructure;

Because of significant risks and a high degree of state regulation, the private sector does not have an interest in entering the MSW market without additional guarantees.

Basic types of PPPs are being introduced in various sectors of the Russian economy. However, there has yet to be a single comprehensive project in waste management that includes multiple MSW components (waste collection and transport, recycling, disposal) and is implemented on the scale of an urban metropolis and/or constituent entity of the federation.

[11] Federal Law No. 89-FZ of 24 June 1998 "On the Production and Consumption Waste."

There are two main barriers to the more active use of PPP mechanisms:

1. The inadequacy of the regulatory and legal framework for PPPs at the federal and regional level. There is a concession agreement, which is formally defined by law and is also the most frequently used form of PPP.[12] However, there is no procedural framework for implementing PPPs. For example, there are no recommendations or directives for the use of PPP mechanisms in implementing regional and municipal programs and no model contracts for various types of PPPs.

2. There is a low level of awareness, primarily at the regional level, of the mechanisms and best practices for entering into PPP agreements and about how to enforce the law.

This often leads to an insufficiently flexible approach in the structuring of agreements. In fact, concession agreements have become synonymous with the term PPP, which prevents the full potential of PPPs from being realized in all of their diversity.

Data support for the decision-making process

The shortage and poor quality of information about the amount and composition of waste complicates the preliminary cost benefit analysis needed for implementing waste management projects. Statistical agencies are currently gathering information on the number of recycling and disposal sites in each region, the volume of waste and the types of hazardous waste being discarded. Data are being gathered on waste that is generated in municipalities or enterprises.

No regular, centralized data collection and analysis of the key waste fractions (packaging, hazardous or bulk waste) are being done. Also, operators (or a municipality acting as an initiator of the project), as a rule, conduct this analysis on their own.

Information on the amount of waste is not always reliable. For example, reporting forms for waste accumulation in the housing sector often use obsolete measurements in cubic meters and do not include weight data (weighing is not always done in landfills).

In the past, MSW was recorded precisely by using volumetric data. This was done since there was a need to calculate the capacity of garbage truck containers and bins. Weight data became crucial for determining the portion of recyclable fractions.

Ineffective data gathering processes are hampering effective monitoring and planning at the federal and regional levels and also contribute to making the sector less transparent to investors. The Presidential Order calls for the creation of a record keeping system at every stage of MSW processing, the registration of disposal sites and the completion of a government waste registry.

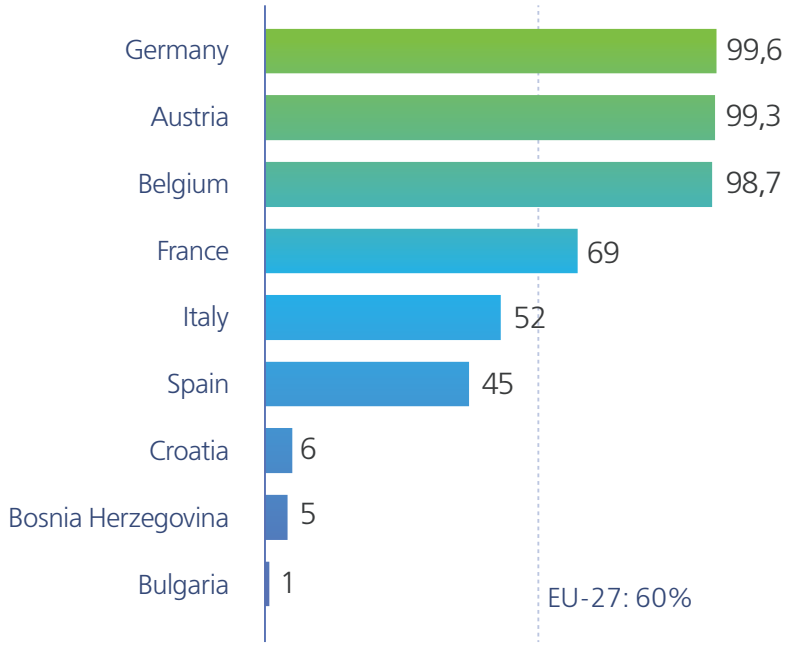
[12] FL No. 115-FZ of 21 July 2005 "On Concession Agreements."

1.3. Analysis of MSW management outside of Russia

A program-oriented approach with a strict definition of priorities

In the EU, 61 million tons of MSW are recycled into secondary materials annually,[13] which exceeds the annual volume of MSW generation in Russia. The recycling rate varies greatly from country to country, from a virtual absence of recycling in some new EU member states to nearly 100 percent recycling in others (Figure 8).

Fig. 8 MSW recycling rates in select European countries, 2010



Source: Eurostat data [19].

To create a balanced waste management system, it is imperative to establish long-range strategic priorities that consider the sanctity of the environment and promote the efficient use of material and energy. MSW (packaging, food waste, used appliances, etc.) is an integral part of the goods and services that households consume.

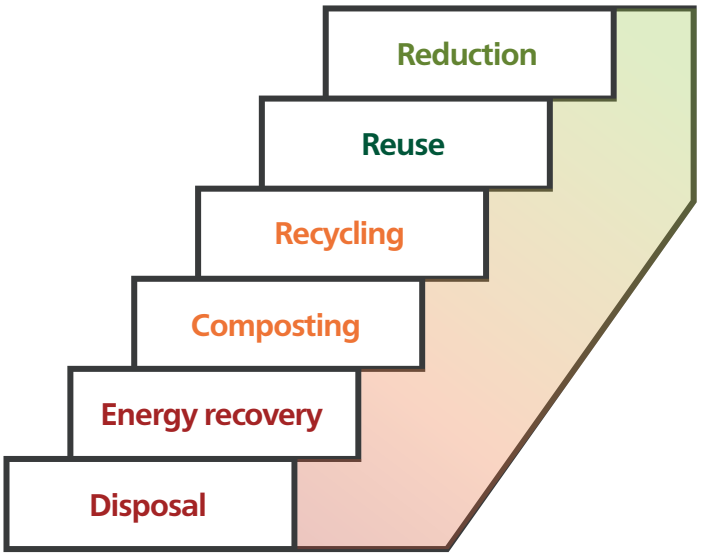
More efficient technologies can reduce the volume of industrial waste significantly. Since the potential for waste reduction in the consumer sector is lower than that of the industrial sector, relatively speaking, reducing the amount of consumer waste generated does not yield significant benefits. Considering this notion, the EU MSW policy focuses on building the most environmentally safe waste management system rather than preventing the generation of waste.

Directive 2008/98/EC, which was adopted in 2008, has a stated priority of minimizing the negative effects of MSW generation and management on the environment and human health.

[13] Excluding composting [20].

The directive establishes basic principles and requirements for organizing an MSW management system. Each country determines the configuration of its own system. According to the Directive, the choice of an MSW management system should be guided above all by considerations for environmental safety and economic efficiency.

All feasible methods are presented in what is known as Lansink's ladder.[14]



The highest priority is the prevention of waste generation.

The most preferred waste processing method is the reuse of waste, because it has a minimal negative impact on the environment. The least preferred method is depositing waste in dumps and landfills. Waste incineration and recycling into secondary materials occupy an intermediate position in the hierarchy. The assumption is that as a waste management system develops, there is a gradual movement up the ladder, i.e. the most environmentally friendly waste management methods will begin to prevail.

As the EU experience has shown, waste management priorities are determined above all by the choices the society makes and by goals established at the national level. In order to set attainable results for projects and programs, it is important to take into account regional differences in the volume and composition of waste, the potential demand for secondary materials and energy, climatic and seasonal factors and the availability and quality of land.

As part of accomplishing the overall task of achieving a high level of recycling, the EU countries prioritize methods that minimize net losses of material and energy. Countries also take into account local factors, when selecting result-oriented approaches, determining which projects to embark upon and selecting specific technologies.

The key to developing waste management systems in the EU countries was to transition from a procedural approach to a programmatic approach. The procedural approach was oriented toward the technical and sanitary regulation of specific procedures plus the stages of waste management. A programmatic approach is based on building a hierarchy of performance targets and developing ways to achieve the targets, while factoring in local conditions.

[14] Eurowaste. Types of waste [21].

The key to developing waste management systems in the EU countries was to transition from a procedural approach to a programmatic approach. The procedural approach was oriented toward the technical and sanitary regulation of specific procedures plus the stages of waste management. A programmatic approach is based on building a hierarchy of performance targets and developing ways to achieve the targets, while factoring in local conditions.

Waste management priorities are established by EC Directives which set the basic principles, requirements and performance targets for operating the MSW system. National legislators define detailed approaches and mechanisms for achieving the desired goals, including setting incentives. Market operators determine the specific procedures and technologies for providing services to reach performance targets and guarantee compliance with EU sanitary and environmental regulations.

It is notable that basic social and environmental standards had to be met during the early stages of the waste management system's development. Specifically, the entire population was required to have access to MSW collection services and MSW had to be responsibly disposed of in landfills that complied with mandatory sanitary requirements.

Only after establishing a basic level of infrastructure was it possible to further develop the sector and implement measures for the more complex process of recycling. The EU countries embarked on this path in various ways. The developed countries evolved in stages and the EU-12 countries developed more quickly than the other EU countries.

Key conclusions for Russia regarding the evolutionary and accelerated upgrade of the Europe's MSW management system

The development of the Belgian and Hungarian MSW management systems is illuminating.

Belgium has one of the most developed waste management systems in the world. As of 2009, less than 4 percent[15] of MSW was disposed of, nearly 40 percent was sent for recycling, 23 percent was composted and 34 percent was incinerated. Additionally, a plan was set to reduce the amount of waste incinerated from 161 kg per capita in 2005 to 150 kg in 2010.

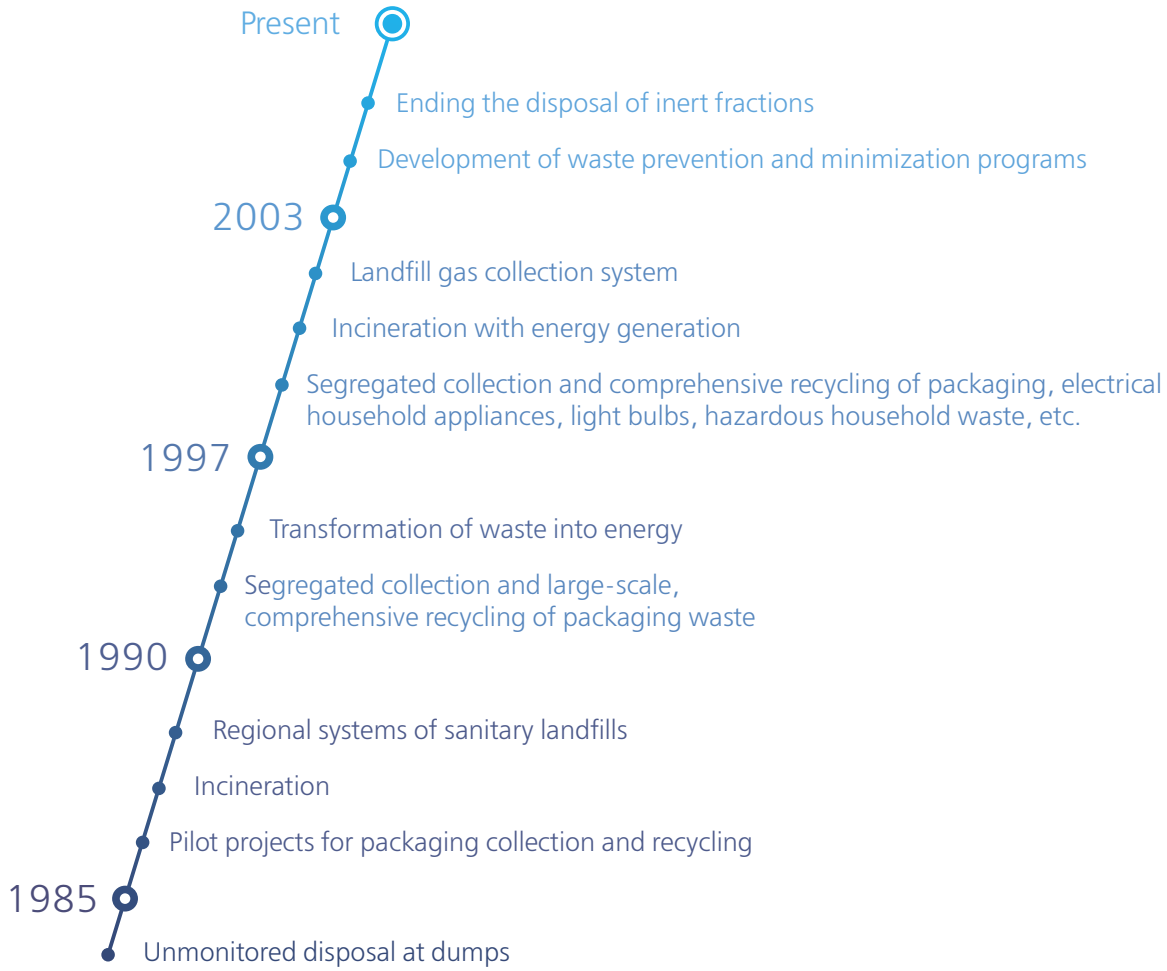
Presently, the share of MSW that is being incinerated has indeed declined. Belgium followed a long path to building its current waste management system. By observing the evolution of recycling in Flanders between 1985 and the present, the main developmental stages of the waste management system in Belgium may be understood. There are five stages that may be defined in Flanders which represent progress up Lansink's ladder (Figure 9).

It took Flanders 35 years to achieve an advanced level of development for its waste management system. This does not mean, however, that another country will have to spend that much time to attain a comparable level of development. Today, there are new technologies and methods for managing MSW that were not available, when Flanders was developing its system. In fact, in some Eastern Europe countries, an advanced waste management system evolved more quickly. Let us consider the case of Hungary.

An intensive change began to occur in the Hungary's waste management system with its admission to the EU. The Waste Management Act, signed into law in 2000, harmonized the Hungarian legislation with that of the European Union.

[15] Here and elsewhere in the text — IFC information.

Fig. 9 The establishment of an MSW management system in Flanders as an example of evolutionary development



Source: IFC.

Targets for recycling packaging waste in the EU

The amount of recycling required for packaging waste is declared in Directive 94/62/EC of 20 December 1994 On Packaging and Packaging Waste.

This directive for the EU member countries contains updatable requirements on the level of recycling for packaging waste in its entirety and also for individual packaging waste fractions. The directive specifies two deadlines for achieving recycling targets: an initial date of December 2001 and a final deadline of December 2008. The deadlines and recycling targets are the same for all the EU member countries. Exceptions were made only for the new EU members that had a low initial level of recycling.

According to the directive, at the end of 2008, 55-80% of all the packaging waste must be transformed into reusable materials. The minimum permissible recycling level for packaging waste is 60%, for glass — 60%, for paper and cardboard — 60%, for plastic — 22.5% and for wood — 15%.

Source: European Parliament and Council Directive 94/62/EC of 20 December 1994 On Packaging and Packaging Waste [22].

The act defined and revised rules and requirements, specified the responsibilities of parties involved in the MSW system and established basic principles regarding responsible waste management, including the EPR principle.

This act led to the adoption of a National Waste Management Action Plan for 2003-2008 which aimed to introduce new requirements to upgrade the institutional infrastructure for developing the sector, as well as to raise public awareness and stimulate scientific and technical research.

The Hungarian example shows that countries with MSW conditions similar to Russia are capable of developing a waste management system in a short period of time.

Notably, effective cooperation between private operators and government authorities is a key factor for achieving positive results. In this regard, the experience of the Eastern European and Balkan countries is revealing. The state of the MSW sector in this region during the mid-1990s was similar to the current situation in Russia in the following ways:

- The municipal infrastructure for waste collection and management was dilapidated;
- The principal funding source for the sector, fees, did not allow for basic modernization, let alone the introduction of advanced technologies;
- Municipal authorities could not manage their own affairs independently. They were hampered by a lack of knowledge regarding mechanisms for regulating the sector and the use of new technologies;
- Residents did not express an interest in receiving a higher quality service.

Only the combined efforts of governmental authorities and private operators made it possible to both generate demand for advanced MSW management mechanisms and deliver services more effectively than municipal operators could have done by acting alone.

The experience of countries such as Hungary demonstrates that by developing recycling, vigorously rehabilitating and reclaiming landfills, and upgrading equipment and machinery for waste collection and transport, it is possible to reduce expenditures on new disposal sites within a time span of 10-12 years.

Similar programs were implemented effectively in 2005-2008 by some of the Balkan countries (Serbia, Montenegro and Albania). The countries that achieved the highest level of recycling (Belgium, Germany and the Netherlands) have, for all practical purposes, ceased disposing of MSW and no longer build new landfills.[16]

In the Baltic countries, as well as the Czech Republic, Slovakia and Hungary, the share of recycled waste increased from practically zero to 20-25 percent[17] between 1998 and 2005. Additionally, disposal at unregulated dumps was almost completely eliminated. Most waste was now being sent to new sites that were built with the participation of private operators, including major European players such as Remondis, SITA and A.S.A. In Russia, it is possible to implement methods and programs that can have similarly transformative effects.

[16] IFC.
[17] Data from the Eurostat Environmental Data Center on Waste, 2012 [23].

The coordinating agent model for managing the municipal waste stream

The most common model in the international MSW sector is the coordinating agent model. Coordinating agents are distinct entities or nonprofit organizations that have an exclusive or partial right to manage waste that is generated in a certain area. The coordinating agents enter into contracts with and make payments to entities that provide services and use the infrastructure as shown in Figure 10.

In this system the coordinating agent is given the power to manage waste streams, select service providers and set fees for public consumers. Municipalities are one of several customer types. They may purchase the following types of services from the coordinating agent: garbage transport from public places, site cleanups and other various services provided to the public sector.

This coordinating agent approach combines a number of characteristics that are essential for implementing the innovation scenario proposed in Chapter 2 of this report:

- A common vision of the end result (an effective system) that makes the market more predictable and transparent for regulators, operators and investors;
- The use of a variety of approaches among different regions for selecting: technology, processing/recycling methods and funding mechanisms (taking into account specific environmental factors and economic conditions);

The preservation of a common approach to monitoring factors that directly affect the environment, specifically the technical and sanitary integrity of infrastructure facilities.

Fig. 10 The coordinating agent's role in the waste management system

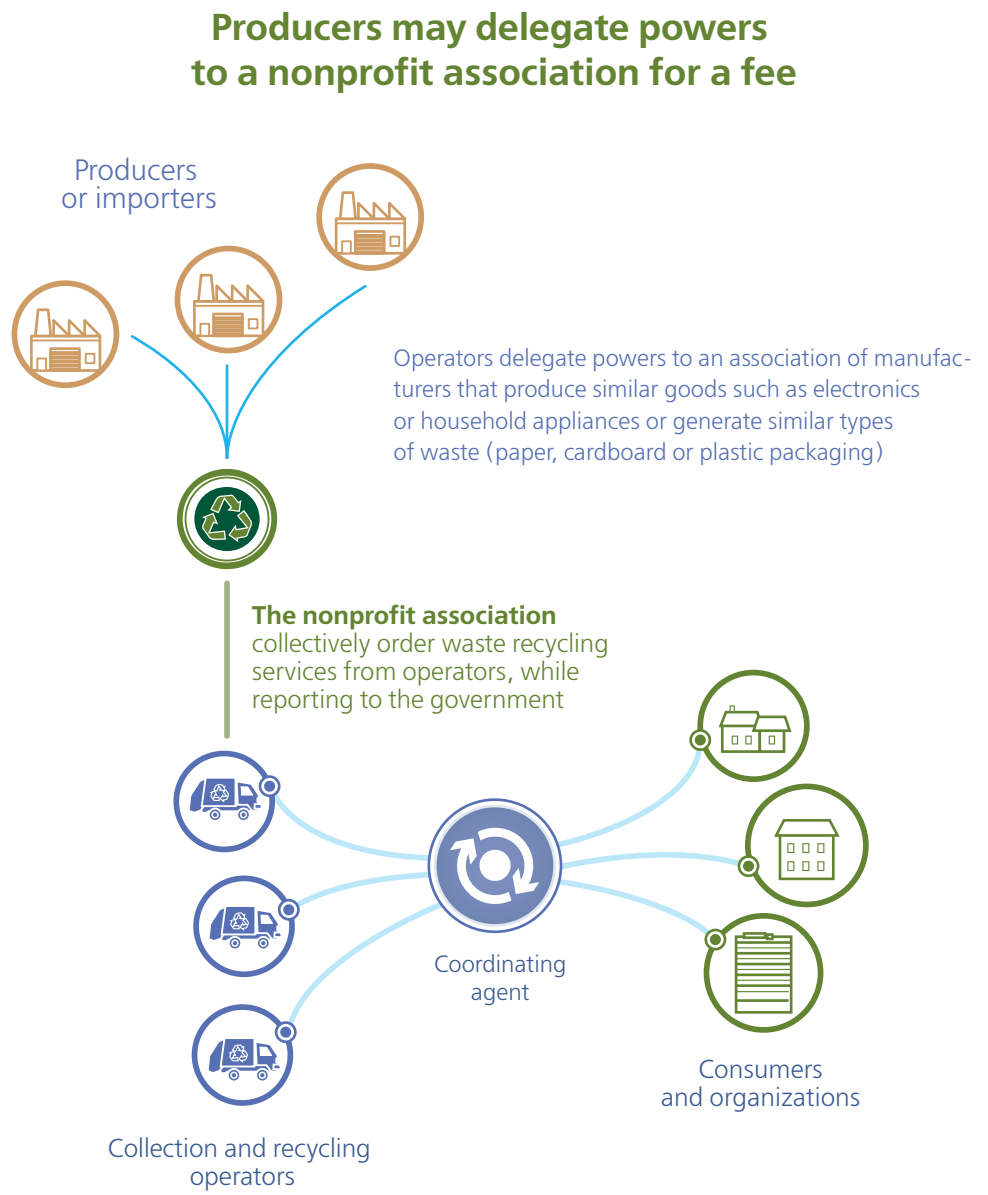
Source: IFC.

The coordinating agent model for implementing the extended producer responsibility principle

An example of using a collective approach to MSW management is Green Dot, an international system that consists of companies that produce goods and services, and waste management organizations. Green Dot participants contribute fees that are proportional to the waste they generate. The collected funds are used for the creation and upkeep of a sufficient recycling infrastructure.

Once a participant makes a contribution, its obligation for contributing to recycling is considered fulfilled. National Green Dot associations verify the contributions with monitoring and reporting systems and the verification process is coordinated with national governments. See Figure 11 for an example of how this mechanism is implemented.

Fig. 11 Organization of waste management systems with the participation of a Green Dot association



Source: IFC.

Additionally, municipalities (regional coordinating agents) often participate in Green Dot systems. In such cases, the EPR principle is fully integrated into the regional MSW management system. In a number of countries, garbage collection and transport services are conducted exclusively within the framework of municipal or regional systems and are funded by fees.

Russia can achieve significant results in the waste recycling industry and minimize waste disposal in landfills by applying the experience of the Eastern European countries which initiated their MSW reforms in conditions that are similar to present-day Russia. Success depends upon the implementation of an effective administrative system. Various versions of the coordinating agent model have performed well in Europe. An adapted form of the coordinating agent model can also be used in Russia, if necessary.

An example of Green Dot system implementation: the Belgian experience

Almost every EU country and a number of other countries have national associations that are members of a single coordinating organization called PRO EUROPE. Green Dot organizations perform the same functions in every country and are structured according to a common principle. The main task of these organizations is to apply the EPR principle to the recycling of packaging waste. Operating on a national scale, these organizations can, for a fee, liberate manufacturers and sellers from the obligation of recycling packaging waste. These institutions are set out to provide recycling services in an economically and environmentally beneficial fashion.

Manufacturers and sellers make contributions to the national Green Dot organization. Packaging for which recycling fees have already been prepaid is marked with the Green Dot symbol. The Green Dot organization, with the help of private and municipal operators, collects and recycles packaging waste marked with the Green Dot symbol. In addition, Green Dot organizations conduct publicity campaigns designed to raise public awareness regarding the importance of proper waste collection.

The configuration of the Green Dot organization, the participation fee and the tasks fulfilled by it vary by country. Currently, the European system serves more than 400 million residents in 34 countries with a segregated collection infrastructure. In 2009, more than 32 million tons of packaging were returned to the economic circulation.

An example of Green Dot system implementation: the Belgian experience.

Belgium is an example of a country that has been highly successful in recycling packaging waste. Its recycling level in 2009 was 93%.

The companies that supply packaged products to the Belgian market may enter into an agreement with the national Green Dot organization, Fost Plus. It has almost 5,500 member companies that make up 92% of the packaging market. The member companies' individual financial contributions are based on the types and volumes of packaging that they declare each year. For example, in 2010, the usage fee for 1 ton of glass was €18.4, for aluminum — €137.9 per ton and for PET bottles — €199.4 per ton. Small companies that produce less than 300 kg of packaging per year that wish to use the Green Dot logo on their products pay a fixed annual fee of €30.

In addition to contributions from the participating companies, Fost Plus receives revenue from the sale of secondary materials.

To organize the collection and sorting of packaging waste, Fost Plus and municipalities enter into five-year agreements which specify in detail waste volumes, collection methods, costs and other items. A municipality is entitled to conduct these operations independently or to delegate them to private operators. The entities that recycle waste are chosen via competitive biddings. Fost Plus conducts active publicity campaigns and participates in developing environmentally safe packaging. The organization has a staff of about 50 people.

Source: PRO EUROPE [24], IFC.


PAPER

Russia will require an investment of €44 billion in order to achieve a recycling and recovery level of 38-40 percent.

Achieving these rates will reduce the projected capacities needed for new disposal facilities by 20-30 percent, while also yielding €2 billion in additional annual revenue from the sale of recycled materials and energy generated from waste.

Chapter 2: Summary and Conclusions

Chapter 2 examines:

- How the European MSW experience can be applied to project and model the trends of both the amount and composition of waste in Russia;
- The most common MSW recycling technologies;
- Which technologies are most suitable for specific regions taking into account characteristics such as size, population density and climate;
- How to define three clusters in Russian regions. MSW implementations are proposed for the unique characteristics of each cluster;
- Two scenarios for developing the MSW sector: a business-as-usual scenario and an innovation scenario. The business-as-usual scenario assumes that current MSW practices will continue unabated, while the innovation scenario introduces recycling. Using a model, calculations are made to project MSW outcomes for each scenario;
- The applicability of using the MSW scenario development model at the regional level.

The main conclusion from this chapter:

1. By implementing the innovation scenario for developing the MSW sector in Russia in the first regional group (Moscow and St. Petersburg), it is possible to achieve a 60-70 percent level of waste recovery by introducing integrated recycling, energy-producing incineration and the segregated collection of the widest possible range of waste fractions. The second regional group is capable of achieving a 30-40 percent level of waste recycling by introducing segregated collection, sorting and secondary recycling. The third group can achieve a 10-12 percent level of recycling by collecting and recycling a mixed waste stream.
2. Both the business-as-usual and innovation scenarios assume that waste which is not recycled will be disposed of in an environmentally safe manner and that unsafe MSW landfills will be closed or rehabilitated.
3. By implementing the innovation scenario the following additional economic and environmental benefits will be possible:
   - The conservation of finite natural resources by replacing traditional energy resources with alternative sources such as landfill gas;
   - The generation of additional energy and heat;
   - Raw materials and supplies are returned to economic circulation;
   - The production of more goods that are made with recycled fractions;
   - The prevention of greenhouse gas emissions at MSW landfills.
4. Calculations based on the model can serve as a basis for establishing performance targets for the MSW sector at the level of a constituent entity of the RF or a municipality.

Chapter 2

Evaluating the potential for developing the sustainable management of MSW in Russia; scenario analyses

2.1. Establishing the model's input parameters based on the European experience

MSW stream management is characterized by the following key parameters:

- Volume generated;
- Waste composition;
- The level of recycling;
- The maturity level of infrastructure development;
- Disposal characteristics.

Some of the model input parameters assume European MSW sector data given the differentiated and at times not compatible methods for statistical data collection in Russia.

By using the principle of Lansink's ladder and relying on the MSW management experience of EU countries, we can propose a number of solutions that will be effective in Russia.

The EU is a useful source for determining achievable development parameters of the MSW management system at the national and regional levels in Russia for the following reasons.

First, the EU is composed of a number of countries with different geographic, climatic, social and economic characteristics and, as a result, different waste management models are used for different circumstances. If we take into account the factors that affect the selection of waste management methods in a given country, the European approach can also be applied in Russia.

Second, there is a clearly identifiable group of countries in the EU (most of which joined after 1995) that in 1998-2000 shared MSW characteristics similar to the current situation in Russia. By applying the experience of other nations that modernized their MSW systems since the 1950s, the EU countries were able to succeed in building an efficient waste management system. Section 1.3 compares the experiences of Belgium and Hungary as representatives of these groups of countries.

Third, the EU waste management statistical record keeping system may be the most detailed system in the world. It consists of data covering every waste management approach in every EU country and includes historical data, which permit the analysis of trends. The data encompasses technical and economic information. The technical one consists of the volume of waste recovered using different methods, recovery levels and the amount of generated material and energy.

The economic information includes capital expenditures and the market value of raw materials, supplies and energy that are generated, as well as other data points.

The European data can be used to evaluate the effectiveness of measures taken in the MSW sector in Russia. Of course, conditions specific to Russia will be taken into account, when evaluating MSW development efforts.

Unit cost estimates based on the level of recycling

Below is a brief description of the most common waste recycling methods in the EU (the technologies are described in more detail in Appendix 2) and the cost per ton of processed waste (costs vary depending on the capacity of the recycling complex). These data form the basis of the cost estimates for implementing various measures within the innovation scenario of development.

The following technologies are the most common.

1 **Recycling a mixed waste stream** is the simplest method of recycling as far as technology is concerned, since it requires the least preliminary waste preparation. This method can recycle waste of any morphological composition. In European and in nascent Russian practice, it is possible to extract 5-20 different fractions from a mixed waste stream using manual and/or automatic sorting. Since there can be a lack of demand in certain regions for specific recycled waste fractions, there would be no need to introduce technology to recover such materials in these regions.

The end product of a recycled mixed stream can serve as an intermediate input material for producing a component that a manufacturer would need to create their final product. Examples of end-products recycled from mixed waste streams include sorted and compacted paper and cardboard waste, glass waste that has been sorted by color and plastic bottles that have been cleaned, sorted and compacted.

Depending on the technical characteristics of the process (the quantity of fractions, the level of automation, the composition of incoming raw materials and the cleanliness of the end-product) the recycling level can vary from 5-20 percent of the incoming waste stream. The cost of recycling can range from €100 per ton of capacity to €250 per ton (for small processing lines with a capacity of 15,000-20,000 tons of waste per year).

2 **Recycling waste that is sorted by type** is similar to the technology discussed above, except that it is more efficient, if preliminary sorting is done by either consumers, when they discard the waste, or at collection facilities for segregated waste and preliminary sorting centers. Waste preparation makes it possible to reduce the amount of investment required to build facilities and can lower operating costs with automation. Only the fractions that will be recycled are sent to the facility.

There are two approaches to collecting presorted waste. The first approach involves collecting the entire group of fractions to be recycled (paper, cardboard, glass, plastic, etc.), followed by the extraction of damp organic waste and contaminated fractions (so-called wet/dry sorting). The second approach involves the preliminary collection of presorted fractions for processing, which typically includes paper, cardboard, glass, plastic (bottles) and metals (aluminum cans).

In the first case, it is possible to recycle 30 percent of the incoming stream — in the second case, up to 40 percent. The amount of investments will also vary. In the first instance, it may be as much as €300 per ton — in the second, up to €400 per ton. It should be noted that a portion of the overall recycling costs (up to €50-70 per ton) will be assumed by the organization that is collecting the presorted waste, while the collection and initial processing of unsorted waste will be a little more expensive due to the elimination of preliminary sorting.

3 **Recycling organic waste** by means of aerobic and/or anaerobic fermentation allows organic fertilizer and biogas to be extracted from biomass. This technique is most often conducted at small facilities (in the EU, up to 40,000-50,000 tons per year per facility). The use of open windrows is the cheapest and technologically simplest method. This technology is used to initiate biological processes, so that they do not develop in a landfill.

It should be noted that the use of a waste product as fertilizer is feasible only if the incoming stream is carefully treated and cleansed of "parasitic" fractions such as glass and metal. Collecting waste to ensure the quality of raw materials could make this technology substantially more expensive. The unit cost of implementing the technology could run from €300 to €600 per ton of capacity, while the attainable recycling level would range from 20 percent to 40 percent.

4 **Waste incineration** that includes energy recovery achieves the highest level of recycling and it is the most technically complex of all the methods described. The complexity is caused by the use of expensive equipment and monitoring methods that limit atmospheric emissions and by the need to constantly regulate an incoming stream of raw materials in order to meet the thermal processing requirements.

The steady and reliable operation of an incineration facility is largely determined by the composition and quality of the incoming waste. It is important to note that monitoring the combustibility of hazardous fractions that have a high heating value (and efficiency of energy production) is quite complicated. The efficiency of such a facility is only maximized when it has a large and continuous flow of waste (from 100,000-150,000 tons per year), which somewhat limits the use of this technology.

The efficiency of the incineration technology may be reduced, when a number of fractions are removed from the waste stream for recycling. In fact, recycling in many EU countries has led to the fact that the efficiency of waste incineration plants is often called into question, since traditional fuel must be purchased to ensure continuous operation.

The waste incineration technology that includes the recycling of energy makes it possible to achieve a recycling level of up to 85 percent. This is possible with an investment of approximately €1,200 per ton per year (the investment amount depends on the incoming raw materials and annual capacity of the incineration plant).

The key parameters from the technologies discussed above that are used as inputs for the model are shown in Table 2.

Table 2. Technical and economic properties of various recycling methods

Waste recycling measures	Attainable recycling level, %	Per-unit investments based on capacity, euros per ton (in 2010 prices)
Recycling with mixed waste streams	5-20	100-250
Recycling with segregated collection (separation of organic waste)	15-30	200-300
Recycling with segregated collection (from four fractions)	30-40	300-400
Biogas production from organic biomass	20-30	300-500
Composting (aerobic fermentation)	30-40	400-600
Garbage incineration with energy recovery	80-85	800-1,200

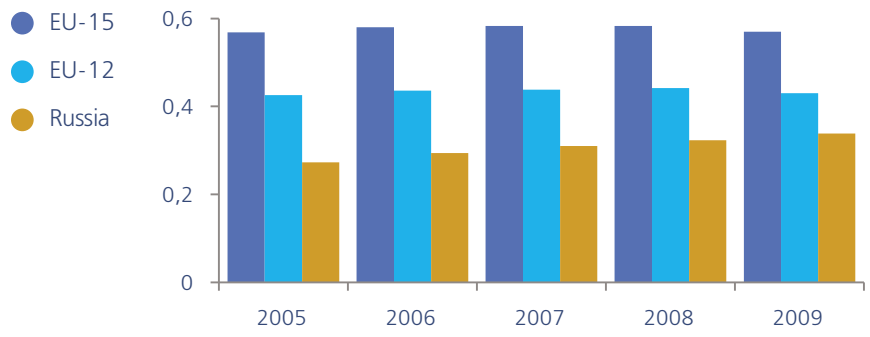
Source: IFC.

Estimating the volume and composition of waste

Since 2005, there has been a steady increase in waste generation in Russia, which has grown in parallel to the rise in living standards.

The EU experience demonstrates that waste generation eventually stabilizes. The stabilization level is different for the EU-12 and the EU-15. This is shown in Figure 12.

Fig. 12 Stabilization of waste generation in Russia and European countries, tons/person



Sources: Rosstat (waste volume and population data) [25]; Eurostat [26].

The growth of MSW per capita in Russia can be expected to continue in the short term and to stabilize in a few years. The growth will be promoted by increasing living standards and changing consumer behaviors. The Russian sector development scenario may be similar to that in the EU-12. Within the framework of GDP growth predictions over the next ten years, the stabilization point is expected to be reached at 450-470 kg of waste per person per year. If one assumes that the current population growth trends continue, by 2025 the annual volume of MSW will have reached 65 million tons.

The relationship between the amount of generated waste and the standard of living has been observed internationally. Average individual volumes of MSW generation in countries with different income levels are shown in Table 3 (World Bank research data).[18] According to the data, high-income countries generate large amounts of MSW per capita. In addition, as income rises, the amount of organic waste relative to MSW decreases, while the share of recyclable fractions increases.[19] This is demonstrated in Table 3,

Changes in the composition of MSW are influenced by many factors, such as climate, cultural tendencies, consumption patterns, the maturity of the waste collection and recycling infrastructure, as well as the availability of record keeping systems. The amount of MSW generated by small and medium-size businesses has so far been insignificant. According to Rosstat data and expert estimates made by MSW operators, the commercial sector's share of waste relative to the total volume of MSW in Russia is no more than 10 percent.

The share of recyclable fractions, such as paper and cardboard, glass, metal and plastic, is expected to grow. There will also be a decline in the share of organic waste. The amount of these waste fractions per capita is close to that of European countries. This means that the potential for MSW recycling is approaching the European level and the volumes of recyclable fractions relative to the overall composition of MSW will probably increase further.

Table 3. Change in the composition of waste relative to personal income levels

	Low-income countries (<$876 GNI/person)	Low to middle-income countries ($876-3,465 GNI/person)	Middle to high-income countries, including Russia ($3,466-10,725 GNI/person)	High-income countries (>$10,725 GNI/person)
MSW generation, tons per person per year	0.22	0.29	0.48	0.78
Organic waste, %	64	59	54	28
Paper and cardboard, %	5	9	14	31
Plastic, %	8	12	11	11
Metal, %	3	2	3	6
Glass, %	3	3	3	7

Source: IFC.

[18] World Bank report "What a Waste: A Global Review of Solid Waste Management," 2012 [27].
[19] Ibidem.

In short, the volume of MSW is expected to grow during the next five to ten years, while the share of recyclable fractions as part of overall MSW will increase and the share of organic waste will decrease.

Factoring in regional characteristics

As shown above, both the types of waste that are generated and, accordingly, the approaches to MSW management are related to living standards (GDP per capita), climate, population density, the level of economic development (urban or rural areas) and other factors.

Because of the immensity of Russia's territory and substantial variations among regions and municipalities, it is not possible to devise a common approach for developing the MSW management sector. Thus, a cluster approach was used to consolidate regions into groups that have similar characteristics. Next, innovative development strategies were created for each group.

The grouping was based on three criteria: GRP per capita, climate type and population density. Under this methodology eight clusters were defined. Since each cluster includes areas with high and low population densities (urban and rural areas, respectively), it is pointless to use an average density at the level of a constituent entity of the federation.

Building waste recycling complexes is only cost-effective when there is a large volume of generated waste (i.e., in cities). Thus, in order to ensure a reasonable payback period for any investments in new MSW systems, areas are delineated, so that they have populations of more than 500,000 (large metropolitan areas).

Since their existing infrastructure required special measures for recycling, Moscow and St. Petersburg were defined as a separate group with unique technological and financial capabilities.

A description of the clusters is presented in Table 4.

Table 4. Clusters and their technological capabilities

Primary cluster	Regions (metropolitan areas)	Volume of waste recycles (millions of tons)	Description	Recovery technologies
A: major metropolitan areas (more than 5 million residents)	Moscow, St. Petersburg	10.4	Densely populated industrial regions with a substantial need for material and energy resources	Segregated collection (four fractions and up) Integrated recycling (MBT) Incineration with energy recovery
B: large metropolitan areas (500,000 residents or more)	Novosibirsk, Yekaterinburg, Nizhny Novgorod, Kazan, Samara, Omsk, Chelyabinsk, Rostov-on-Don, Ufa, Volgograd, Krasnoyarsk, Perm, Voronezh and others	27.9	Densely populated regions	Partial segregated collection (two groups of fractions) Recycling
			Densely populated regions with large volumes of industrial output	Segregated collection (four fractions and up) Integrated recycling (MBT)
			Densely populated industrial regions with a substantial need for material and energy resources	Separate collection (four fractions and up) Integrated recycling (MBT) Incineration with energy recovery
C: small metropolitan areas and areas of the constituent entities not included in groups A and B	Lipetsk, Kirov, Cheboksary, Kaliningrad, Kursk, Stavropol, Briansk and others	26.8	Sparsely populated areas	Collection and recycling of a mixed waste stream
			Industrial centers	Partial segregated collection (two types of fractions)
Total:		65.1		

Source: IFC.

2.2. The business-as-usual and innovative development scenarios of the MSW management sector in Russia

Minimizing the impact of waste on the environment is the most important principle of a sustainable MSW system. The same assumptions, which were described in Section 2.1, were used to model both the innovation and business-as-usual scenarios. We hope all this has made it possible to fully demonstrate the effect of an increase in the volumes of waste recycling compared with the baseline level. The planning horizon is 2025.

The business-as-usual development scenario

The business-as-usual scenario assumes that the trend of development that occurred in the Russian MSW sector from 2000-2010 will continue, except that a level of environmental safety found in the EU will be achieved.

This scenario calls for a number of key accomplishments by 2025:

1. The remediation of inactive landfills that have yet to be shut down in an environmentally safe manner, including disposal sites that are scheduled to be closed by 2025.

2. Taking inventory of active disposal sites, in order to determine which landfills must be upgraded or closed and then rehabilitated. This involves a set of measures to ensure compliance with Russian law and, in the longer term, with the EU standards. Upgrades include a number of basic measures:

   - The implementation of systems for inspecting the weight and composition of incoming waste;
   - The installation of leachate collection systems and the capture and recovery of landfill gas;
   - The removal of unsuitable types of waste from landfills, which involves pumping out hazardous liquid waste such as oils and properly disposing of construction waste;
   - The removal of other types of waste from landfills, such as automobile tires, bulk garbage and industrial packaging;
   - The closing and rehabilitation of landfills, which cannot benefit from basic improvements.

3. A comprehensive upgrade of equipment at transfer stations, containers and specialized transportation vehicles. The need for modernization is based on the degree of equipment wear and tear. As of 2010, the level of wear and tear for various types of organizations varied from 30 percent to 70 percent. The current pace of upgrades and the investment programs provided for upgrades is insufficient, especially considering the projected increase in the volume of MSW.

According to experts' estimates, about 1,200 disposal sites in Russia will require rehabilitation by 2025. More than half of these sites are expansive, covering more than 10 hectares and located within 30 kilometers from major metropolitan areas and even within their boundaries.

Since the volume of incoming waste will increase by 10-15 percent annually, while active sites (landfills and regulated dumping grounds) are filled to an average of 70 percent capacity, the avoidance of widespread, unmonitored disposal will require the construction of more than 1,000 new facilities. And since the volume of MSW is not decreasing, the new facilities will occupy an amount of land equal to that of current sites. In addition, restoration will be required for the same number of sites that will be closed, most of which are quite large.

Based on the business-as-usual model, construction costs for new, sanitary landfills with a service life up to 15 years are estimated to be €19.5 billion (in 2010 prices). Modernizing existing waste collection and disposal sites will cost at least €15.8 billion. Another €2 billion will be required for the construction of new facilities.

Therefore, the total cost of implementing this scenario in Russia will be at least €37.3 billion. This total does not include the amount already allocated for the ongoing construction of waste recycling facilities (as a rule, with a low or medium capacity) in various regions via a number of earmarked programs.

However, the waste recycling facilities to be commissioned will have an average capacity of no more than 100,000 tons per year (according to 2010-2011 data). Such an effort will only make it possible to maintain the overall recycling level of 5-7 percent. It is worth noting that these projects will not affect the continued growth trend of accumulated waste.

The innovation development scenario

To model the innovation scenario, Russia's regions were divided into three clusters. Using this cluster approach, regional specializations of MSW management methods were determined on the basis of specific regional characteristics. Unit costs were taken from Table 2 (see Section 2.1).

When determining the optimal recycling approach for a specific region, it is important to select a proper mix of technologies suitable for achieving the desired level of recycling and cost effectiveness. As a rule, the benefits correlate with the unit cost of implementation.

The results of the calculations for each cluster are presented in Table 5.

Table 5. Recycling in the clusters

Primary cluster	Capital investments, millions of euros	Capital investments, millions of euros
A: major metropolitan areas (more than 5 million residents)	60-70	4500
B: large metropolitan areas (500,000 residents or more)	4,500	7344
C: small metropolitan areas and areas of the constituent entities not included in groups A and B	10-20	2,923
Total:		**14,767**

Source: IFC.

Figure 13 illustrates the calculations results for the recycling component under the innovation scenario.

Fig. 13 Calculating results for the innovation scenario (recycling component)

Source: IFC.

In the innovation scenario, the waste collection and disposal system is also modernized, since this is essential for ensuring the environmentally safe operation of the system's key assets throughout their service lives. Since recycling is implemented gradually, it cannot completely replace the need to build and operate new MSW landfills. However, in this scenario, the amount of new landfills required will decline over time. The construction costs for new landfills will be €16.2 billion.

The innovation scenario should not be regarded as the only correct development path for waste management. It is merely one alternative that shows how the European experience can be applied in Russia to generate attainable results.

At the regional and national levels, government authorities, state companies and private companies may adopt waste recycling solutions with technical and economic characteristics that differ from those proposed in this report. No ceiling may be imposed in terms of the technological potential. Still, the proposed approach will undoubtedly be beneficial at any level, in particular for the constituent entities of the federation, municipalities and company management that work in the sector.

Implementation of the innovation scenario will result in the indirect economic gains described in Table 6.

Table 6. Average annual environmental benefits and indirect economic gains achieved by the innovation development scenario for the MSW management sector in Russia

No.	Indicator	Value in physical units	Value in millions of euros (in 2010 prices)
1.	Electricity production at incineration plants (also from incinerating landfill gas)	397,882 MWh	43.8
2.	Heat production at incineration plants (also from incinerating landfill gas)	496,415 MWh	74.5
3.	Conservation of primary energy sources	109,851 MWh	
4.	Avoided landfill disposal or valuable raw materials returned to economic circulation	25.6 mln t of standard fuel	1,852.0
5.	Reduction of greenhouse gas emissions due to a decrease in the amount of waste disposal in landfills	18 mln t CO2 equiv.	

Source: IFC.

Results of scenario analysis

A comparative analysis of the business-as-usual and innovation development scenarios for the MSW management sector in Russia up to 2025 is presented in Table 7.

Table 7. Results of calculations for the scenarios

Measures	Scenarios and their results by 2025	
	Business-as-usual scenario	Innovation scenario
Modernization of the MSW collection, transportation and disposal system, billions of euros	15.8	12.9
Construction of new recycling facilities, excluding planned projects, billions of euros	2	14.8
Construction of new landfills, billions of euros	19.5	16
TOTAL, billions of euros	**37.3**	**43.8**
Recycling level, %	**5-7**	**38-40**
Per capita costs, euros per person per year	**34.45**	**38.16**

Source: IFC.

Today, Russia can choose a development path for a sustainable MSW system that aims to *create an environmentally sustainable disposal infrastructure and quickly adopts recycling technologies.*

If the MSW policy in Russia gets focused on modernizing the collection, transportation and disposal infrastructure, it is realistic to achieve environmentally safe waste management by 2025 at the current pace, for which recycling technology is being implemented. Such a path would require *investments of more than €37 billion (in 2010 prices)*. Yet, the amount of waste that is recycled will remain at 5-7 percent of the overall volume of MSW.

If Russia follows the example of the EU countries and adjusts policies to accommodate the unique characteristics of each cluster or region, and also introduces *recycling*, then by 2025 the level of recycling will have reached 38-40 percent of the overall amount of MSW. Additionally, Russia will be able to use environmentally safe practices for operating infrastructure facilities, including MSW landfills. Achieving this level of recycling will require *total investments of €43.8 billion.*

The innovation scenario is the most appropriate path for Russia. Not only will it reduce the amount of waste sent to landfills, but will also return about *380 million tons of useful materials* to the economic circulation, eliminating some of the need to extract fresh resources to be used in manufacturing.

Opening new MSW recycling plants will create thousands of jobs, boosting GDP by an additional 1-1.5 percent. This is approximately equivalent to the level of GDP generated by the hotel and hospitality industry in 2011. The additional revenue from the sale of secondary raw materials and supplies by 2025 (over a 15-year period) will have amounted to about *€26 billion.* In addition, during the period up to 2025, the total CO2 emissions will decline by 269 million tons of CO2 equivalent.

The MSW management sector in Russia is currently underfunded. In a number of regions the total payment for MSW management per person is about €3-4 per year. This does not even cover the day-to-day costs of safely operating the MSW system, not to mention the cost of investing in new infrastructure. By comparison, waste management costs per person for households in the EU countries average *0.5-1 percent of disposable income.*

Depending on which scenario is chosen, capital and operating expenditures per capita per year will amount to €34-38 per person in 2010 prices, which is seven times higher than the average revenue generated from MSW fees in 2010. When adjusted for the projected inflation, the nominal payment amount will be even higher.

Russia faces the challenge of introducing an effective compensation system that will cover MSW operators' costs while encouraging recycling and minimizing the amount of MSW that ends up in landfills. However, such a compensation system should not result in a decline in the standards of living.

Applying the model to regions in the Russian Federation

The model from the IFC scenarios can be applied to the constituent entities (regions) of the Russian Federation, which would require the following information:

1. The quantity and composition of generated waste;
2. The condition of landfills and their available and used capacities;
3. The service life of landfills.

By applying the model to a constituent entity using the information listed above, it will be possible to determine the feasible level of recycling for specific fractions, as well as the scale required for such items as the segregated collection and sorting of waste. Depending on the size of the metropolitan areas within a constituent entity it might be advisable to use a cluster approach at the regional level.

The model will enable processing various scenarios, in order to determine waste management performance targets, required investments, operating costs and the level of user fees. Minimum and maximum user fees can be set in the model in order to arrive at a viable funding scenario.

In some cases, setting relatively high fees could make it impossible to reach higher levels of recycling, resulting in a situation, where recycling technologies are neither cost effective nor attractive to potential investors.

With a reliable set of data that is regularly replenished, the model will be instrumental in refining performance targets and can serve as a tool for formulating and adjusting MSW strategies for a particular constituent entity.

More than 14,700 authorized waste disposal sites occupy an area of about 4 million hectares, which is comparable to the area of Switzerland and the Netherlands.

Each year 400,000 hectares of land, or 40 percent more than the area of Luxembourg, is allocated for MSW disposal.

Chapter 3: Summary and Conclusions

Chapter 3 examines:

- Financial, administrative, informational and cultural challenges for developing an efficient MSW system. Potential solutions to these problems are also discussed;
- A roadmap for improving the MSW system by 2025;
- The socio-economic importance and impact of developing a sustainable MSW sector.

This chapter reaches the following conclusions:

1. In order to ensure that there are enough funds to cover operational and capital expenditures, the system of payment and fees must be improved. The polluter pays principle should be introduced.
2. Introducing EPR will help generate the necessary funds for recycling the most recoverable waste fractions.
3. It is impossible to advance the MSW sector without implementing a programmatic approach that includes performance targets, setting strict deadlines for achieving the targets, monitoring progress and making adjustments, as needed.
4. A single government agency that operates on both the federal and constituent entity levels should be formed. It should be responsible for implementing the national MSW strategy in line with a roadmap.
5. By introducing coordinating agents, it will be possible to establish a stable source of funding, ensure the dissemination of knowledge and technologies, and attract the private sector using PPPs.
6. The type of PPP should be selected based on the unique characteristics of each project.
7. The MSW sector cannot be managed effectively without regularly obtaining accurate data and keeping the public informed.

Chapter 3

Moving towards a sustainable MSW system in Russia

3.1. Guiding principles for improving the MSW management system

As demonstrated in Chapter 1, the market for MSW management services in Russia has a considerable potential. The market participants increasingly recognize it, but investments in the sector have been weak, since private Russian companies and major international operators are cautious about entering the market.

The development of a market for MSW in Russia that involves the active participation of private businesses is impeded by a number of barriers. There are three major types of them: administrative, financial and cultural. The challenges facing the MSW sector and ways to resolve them are listed in order of priority within this chapter. The major reasons for the sector to lag behind its foreign counterparts are underfunding and a lack of economic incentives for improving the sector.

Financial barriers exist due to a lack of a sustainable source of funding that would guarantee the payback of investments in MSW system upgrades. Financial barriers exist in part because it is a challenge to set and regulate fees and other waste-related payments and also since there is a lack of economic incentives for recycling.

Administrative barriers reduce the transparency of the sector and, thus, discourage new participants from entering the market. Potential market participants cannot obtain the comprehensive information needed to make smart decisions, and eliminating the uncertainty is quite costly. Administrative barriers also include the ill-defined division of responsibilities among the market participants, the rigidity of PPP mechanisms, the lack of accurate data on waste and the challenges of regulating the technology and protecting the environment.

Cultural and awareness barriers manifest themselves due to a lack of public awareness regarding the importance of proper waste management. As a result, there is essentially no public demand for adequate services. Implementing measures to improve waste management requires a change of attitude on the part of both the public and the government. It is essential to cultivate a fundamentally different cultural attitude about waste and to develop new standards and rules of behavior regarding MSW. **Developing a new attitude among consumers is quite complex, since there is no immediately obvious savings benefit for them.**

It is impossible to overcome these barriers without the active participation of the authorities at every level. In order to develop a market for environmental services in the MSW management sector that would be attractive for private investors, institutional change must be based on an analysis of the MSW sector in Russia along with the best examples of MSW systems outside of Russia (described in Chapter 1).

1. Improving the system of fees and payments

A stable source of funding is critical for supporting the successful operation of MSW enterprises and the sector as a whole. In order to create a stable source of funding, the system of fees and payments must:

- Generate enough funds to cover operating and capital expenditures;
- Provide incentives for producers and consumers to manage waste more sensibly;
- Encourage the implementation of economically and environmentally beneficial waste management methods and low-waste technologies.

The polluter pays principle consists of the following:

- Waste processing costs are covered by the party that produced the waste;
- The environmental impact costs are considered, including the costs of remediating landfills, environmental restoration and the amortization of facilities. Amortizing facilities involves setting aside a pool of funds for the construction of replacements.

In the international MSW sector, the term "polluter" is interpreted in a broad sense. A polluter is not only a private citizen or organization; it is also a producer and/or seller of a product that requires recycling at the end of its life cycle. In order for producers to account for the waste that they generate, they should be required to organize a recycling system, either independently (by collecting and processing) or collectively (through industry associations and common coordinating agents).

Investments by producers may result in increased costs, which may be passed along to consumers. In order to minimize the financial burden on households, producers will have to invest in minimizing the generation of waste. Such investments should include using environmentally friendly packaging, manufacturing products from recyclable materials and encouraging consumers to manage waste sensibly. In the Central and Eastern European countries that implemented EPR programs for packaging in 1998-2008, there has been virtually no effect on the price of end products.

In order to improve the waste management system, there must be a regulatory mechanism that provides an incentive for producers to minimize the disposal of recoverable waste fractions in landfills without shifting the responsibility to consumers.

Without proper incentives, even motivated end users and coordinating agents will not be able to act effectively within the MSW system. Furthermore, motivated end users and coordinating agents

What does extended producer responsibility mean?

Extended producer responsibility means that suppliers must arrange for the safe recovery of their end products in accordance with the law. An authorized government agency oversees this responsibility. As a rule, this oversight is done by comparing the number of products that enter the market versus the number of products that exit the market.

The producer's stranded costs for obtaining recyclable fractions, as a rule, are passed along to the consumer, and are subject to subsidies.

Uniform landfill waste disposal fees

The amount of the fee is determined either at the regional or municipal level and depends on the state of the environment in the region, the quantity of MSW, the availability and condition of the MSW infrastructure, the possibility of construction of new disposal facilities and the cost of building and maintaining a waste recycling infrastructure that prevents waste from being disposed of in a landfill.

The fee is set in order to incentivize the consumer to minimize sending waste to a landfill. And if sending waste to a landfill is unavoidable, the fee should cover the entire cost of the environmental impact.

This practice accomplishes two tasks: it makes recycling cost-effective and allows forming a pool of funds at the regional level to co-finance rehabilitation and remediation projects for waste disposal facilities.

do not possess sufficient knowledge on how to reuse or recycle and have limited access to low-waste producing technologies. These factors prevent motivated users and coordinating agents from implementing the best processing options for recovering material, from ensuring the safe disposal of waste and from minimizing the volume of waste generated from production processes.

These problems can be alleviated by expanding the concept of the "polluter" in the polluter pays principle and by introducing this concept in the manufacturing supply chain. In short, this can be achieved by introducing the extended producer responsibility (EPR) principle.

Applying EPR in Russia will stimulate the recovery of the most important MSW fractions, encourage new investments in the sector and help make the waste management payment system more efficient.

And by adjusting the funding mechanisms for the MSW system as described above, the following benefits will emerge:

1. By setting fees in proportion to consumption levels, people consuming less resources will be enabled to reduce their payments for MSW services.
2. New actors will emerge, who will be interested in co-investing in the collection, recovery and disposal infrastructure.
3. Manufacturers will have an incentive to adjust products, so that they are more suitable for recycling or generate smaller quantities of waste.

Furthermore, a number of reforms are necessary to implement the polluter pays principle:

- Emphasize to the public and commercial sector that waste management will have a transparent payment structure.
- Phase-in service fees that are proportional to consumption levels. Additionally, create a pay-as-you-throw system that consists of payments that are proportional to the volume of discarded waste (instead of setting fees and providing services in relation to the square footage of a site). Additionally, prepayments should be established for the collection of waste containers, bulk garbage, electronic equipment and hazardous waste.
- Implement the EPR principle by first phasing in processing operations for waste that is commercially attractive (such as packaging waste) and requires intensive recovery and decontamination processes (such as those needed for batteries, lamps and aerosols).

- The federal authorities should define a clear-cut methodology for calculating MSW disposal fees that factor in the cost of maintaining landfills for their entire life cycles. The life cycle consists of constructing, operating, closing and rehabilitating a landfill. Alternatively, a regional compensation fee could be introduced to cover the environmental restoration costs within the jurisdiction of a coordinating agent.

2. A programmatic and goal-oriented approach to waste management

The following functions and responsibilities are recommended for the various levels of the Russian government:

1. **Federal level:** create a national waste management strategy that sets targets for the collection, recovery and disposal of waste. Targets should be created for the total amount of waste, as well as the primary waste fractions. Additionally, a legal framework should be created to: establish sanitary and technical requirements that support infrastructure facilities, create a monitoring system and stimulate the development of MSW management expertise.

2. **Constituent entities of the RF:** create a regional waste management strategy that sets specific performance targets and defines mechanisms for reaching the targets. The strategy should describe how fees should be established along with who will be charged for particular services. The strategy should also describe how to attract private capital and how to go about identifying where infrastructure facilities should be located. When defining performance targets, priority must be given to the segregated collection and recovery of MSW rather than MSW disposal, taking into account the condition of infrastructure, the volume and composition of MSW, the demand for secondary materials and the regional climate.

3. **Municipal entities:** create an operational MSW collection system for cities that is managed by an operator or group of operators and monitor the day-to-day activities of the operators.

In order to properly coordinate the nationwide MSW strategy, a designated authority at the federal level should be established or an existing agency in the executive branch should be vested with coordination authority. The coordinating agency should have the following powers and responsibilities:

- Supervise the establishment and delegation of objectives and tasks at the regional and municipal levels, monitor progress for achieving objectives and completing tasks, assess the implementation of national MSW objectives, regularly review the national strategy and, when necessary, initiate changes to laws.

Mechanisms for implementing the pay-as-you-throw principle

1. **Place prepaid waste collection containers** near residences or at special collection stations. Operators may sell containers directly or via authorized entities, as agreed upon with the client (the coordinating agent).
2. **Establish special vouchers** or labels guaranteeing the transport and/or utilization of certain types of waste such as bulk garbage and household appliances.
3. **Set fees in proportion to the weight** of garbage that has been taken away.

Recommendations for improving the system of payments and fees for MSW management services

Disclose all the elements of the fees.

Specific and unique MSW management services should be rendered to all types of customers. Also, the customers should be provided with complete information about all elements of a fee. This will result in transparency for all fees, enabling consumers to see how a bill is broken down into individually charged service items.

Implement a pay-as-you-throw fee system.

Regional MSW management systems should include pay-as-you-throw mechanisms, such as prepaid packaging, vouchers and weight-based fees.

At the regional waste management system, a mechanism should be created that determines the compensation for negative impacts on the environment.

Introduce new economic incentives in conjunction with the current fee structure for disposal and compensation for the negative effects of waste.

1. Create a fee for operators who dispose of waste in landfills to compensate for the full costs of rehabilitating and remediating a facility, as well as the costs of other negative effects. The fee amount should be determined at the regional level on the basis of a national methodology.
2. Establish an environmental fee to provide an incentive for recycling as an alternative to waste disposal in landfills.

Additionally, a federal fund could be set up in order to implement national projects such as co-financing the recycling of accumulated waste and remediating closed landfills in regions that do not have access to other sources of funding.

Compensate for the negative social impact of higher fees.

To alleviate the effect of higher fees for those that would find them to be a burden, compensatory measures must be introduced for specific categories of consumers.

1. Provide benefits and compensation for low-income individuals, as well as enterprises and organizations that perform important social functions. Benefits may be provided in the form of a full or partial payment exemption.
2. Allocate, where feasible and necessary, federal and regional subsidies for the implementation of recycling projects. Alternatively, reduced coefficients for environmental payments can be introduced. These subsidies can also be used instead of raising any fees to compensate for the depreciation costs of a portion of capital expenditures.

- Coordinate MSW strategies for the regions;
- Provide methodological support;
- Coordinate with other agencies responsible for waste management, such as the Russian Federation Ministry of Natural Resources and the Environment;
- Coordinate the operation of a common database for things like cadasters, registries and reports.

Using a coordinating agent to effectively coordinate MSW management at the regional and municipal levels

In order to successfully transform the MSW management system, operational authority should be concentrated where most activities are actually conducted, i.e., at the level of the federation's constituent entities and municipalities. Thus, the laws "On the Financial Fundamentals of Local Self-Government in the Russian Federation"21[20] and "On the Production and Consumption Waste"22[21] assign authority for various tasks to constituent entities and municipalities for organizing waste management, setting the location of infrastructure facilities and collecting household waste.

To ensure that these functions are carried out in their entirety, regional authorities should be given the exclusive right to manage waste generated in their region. And, as has been done internationally, they should be granted the exclusive right to implement the common coordinating agent model (see Section 1.3).

The appearance of a single authorized coordinating agent at the regional level will enable:

- The definition of waste management as a unique type of utility service;
- The consolidation and centralization of disaggregated cash flows, proper oversight of MSW infrastructure and facilities;
- Continuous performance monitoring.

Once the possibilities listed above are realized, the MSW sector will become much more attractive to investors, since the cost of doing business in it will drop. There is a high cost of doing business in the current system, since there are many independent market participants, who, by default, are carrying out the market coordination functions that should be handled by the municipal and constituent entities.

A system that relies on a coordinating agent does not restrict the diversity of contractors and types of legal ownership. Instead, the coordinating agent functions as a common client. By having a common client, it is possible to attract adequate financial resources, disseminate knowledge and technologies and involve companies in the implementation of comprehensive PPP projects. When large contractors are not able to ensure the quality of certain services (such as the management of certain types of waste, the implementation of specific recovery technologies and planning and surveying) small and medium-size companies can be recruited to fulfill such tasks.

As a rule, the common coordinating agent system works best in large metropolitan areas, small towns or at existing infrastructure sites (such as landfills). For example, multiple municipalities within a constituent entity can be managed under a single coordinating agent.

[20] FL No. 126-FZ of 25 September 1997.
[21] FL No. 89-FZ of 24 June 1998.

Municipalities shall be granted the right to choose the level of coordination that is best for them based on factors such as the availability, location and forms of ownership for infrastructure facilities. They should also have the ability to periodically change the management approach via public procedures that enable all stakeholders to express their needs.

The coordinating agent system can be implemented in a variety of ways, primarily with regard to the scope of services, administration of payments and the form an organization will take

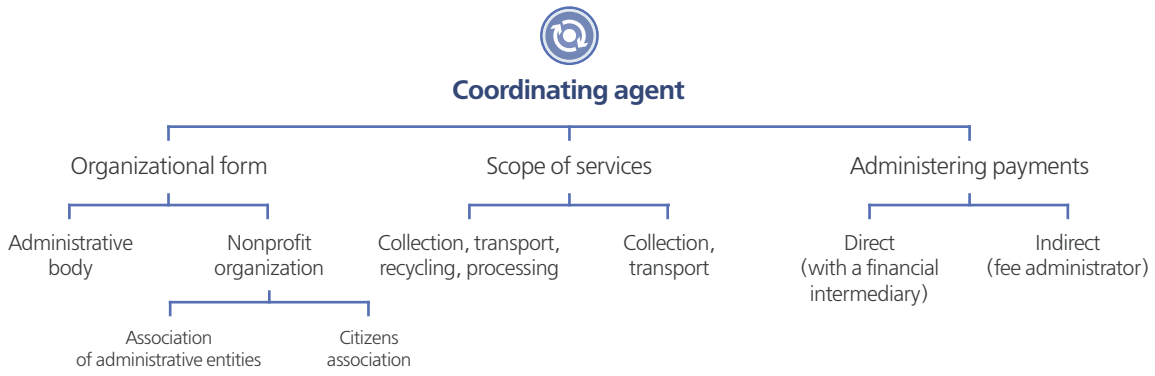
1. **Scope of services.** For MSW market segments that are both firmly established and competitive, additional intermediaries acting as a coordinating agent may be superfluous. As has been the case in a number of countries, for certain market segments companies are capable of handling the collection of MSW directly. However, facilities that are managed within a coordinated system handle the recovery and disposal of waste.

2. A**dministering payments.** There are two possibilities for establishing a payment system. The first is to channel payments through a coordinating agent. The second is to allow authorized entities to manage the fee collection system. In the latter case, fees collected from consumers would be transferred to MSW operators. The choice of a payment system depends on the degree, to which regional and local authorities plan to use budgetary funds for the administration of finances (such as consolidating municipal procurement, subsidizing certain consumers and financing the budget).

3. **Organizational form.** The coordinating agent can be either an administrative body or a nonprofit. For example, a group of consumers, who are using an MSW service, can act as a nonprofit coordinating agent. Governing bodies of the coordinating agent can include representatives of the administration. This enables the general public and organizations to participate more actively in MSW management in their constituent entity or region.

The framework of coordinating agent system approaches is shown in Figure 14.

Fig. 14 Coordinating agent's functions in a waste management system



Source: IFC.

In short, a coordinating agent can successfully carry out its functions at all the levels: the municipal level, the inter-municipal level and the level of a constituent entity of the federation. In practice, the nature of the coordinating agent is determined by the location where waste is being generated or processed.

4. Implementing extended producer responsibility (EPR)

Internationally, there are several EPR models with some of their features being different. One model involves removing an item from the circulation once its service life is over. It is removed at the expense of the manufacturer and the manufacturer recycles the item. Alternatively, recycling is delegated to a specialized entity, which is paid for its services.

This model, or any other EPR mechanism, can be applied by a single company, or it can be executed on a collective basis via a nonprofit association of manufacturers making similar products. A collective implementation is advantageous, since a common recycling infrastructure can be financed on a large scale by multiple companies.

Additionally, by implementing EPR via a collective organization, it is easier to reach agreements with governments regarding a monitoring and reporting system for a specific type of product. Also, manufacturer groups can be established for a whole range of products, making it possible to determine how much each company should pay to compensate for their fair share of recycling and processing.

A large portion of manufacturers in the EU fulfill their obligations through a system of collective responsibility.

Recommendations for developing waste management market

Create and empower a common coordinating center at the subfederal level.
When creating the center, the preservation of competition should be guaranteed in the areas that attract private businesses. Additionally, progress towards fulfilling regional waste management targets should be monitored.

Provide for the ability to implement the principle of a coordinating agent by revising legislative acts — specifically, laws regarding waste, environmental protection and the organization of local self-government. Additionally, regional and local regulations should be adjusted.

Develop a simple type of a coordinating agent.
The simplest systems should be implemented first. A simple system should consist of an entire range of waste management services or it can be divided up into collection and transport. In either case, payments should be managed directly. As experience is accumulated, one can expect that constituent entities will use multiple approaches.

Allow regions to select their own subsystems.

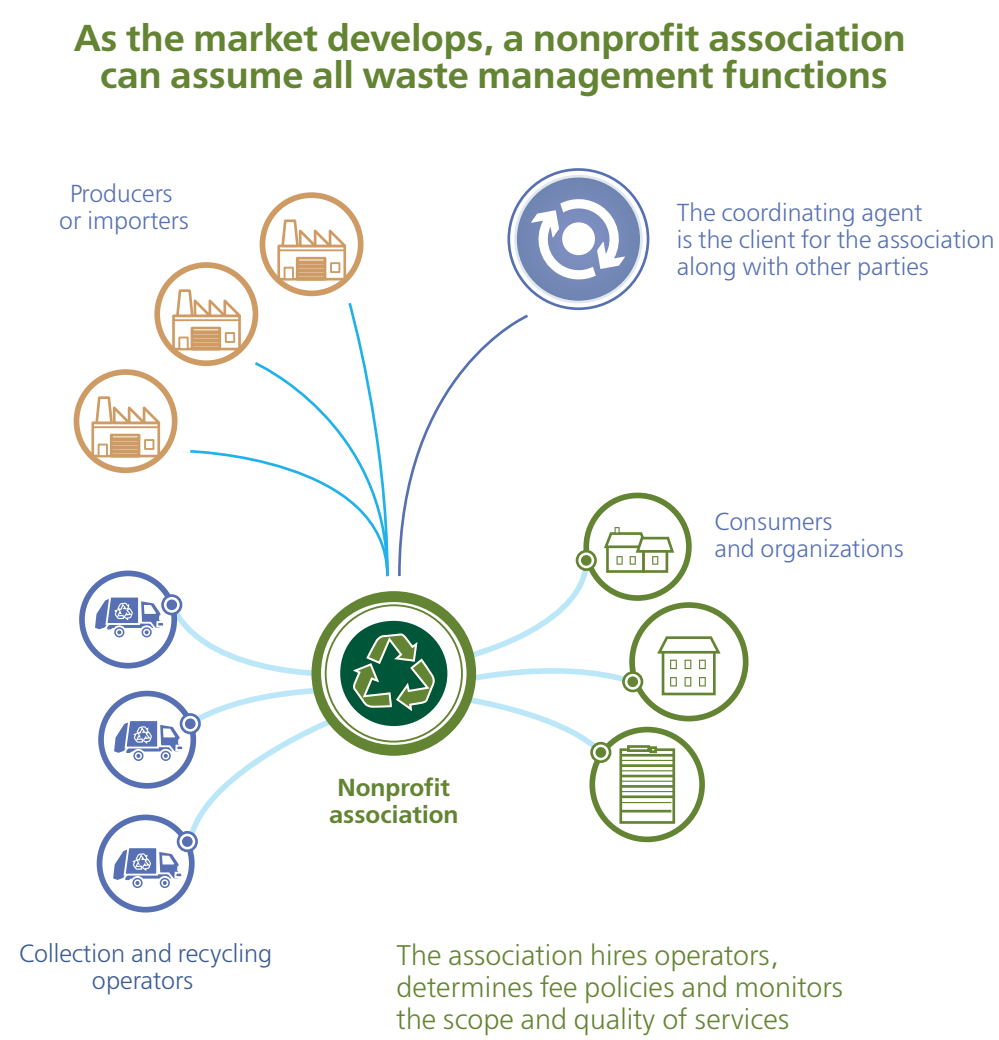
A constituent entity of the federation should decide which subsystems will function best in their region. When choosing a subsystem, the established practices and needs of municipalities must be considered. Most likely, coordination in the initial phase will take place at the level of constituent entities and large metropolitan areas.

An **individual system, as opposed to a collective system**, is less transparent to the government, since the amount of waste each manufacturer generates is more difficult to monitor. On the other hand, such a system provides a better incentive for a specific company to use low-waste technologies and eliminates the problem of freeloaders. Freeloaders are participants in the collective system that take advantage of opportunities to pay less at the expense of others.

A number of large international companies such as Hewlett-Packard are proponents of an individual system. This is the case because they already have systems for recycling their products and possesses enough resources to arrange for the necessary infrastructure (including transportation) on both a national and international scale.

Figure 15 below demonstrates how regional entities interact within the framework of an EPR program that is compliant with the Russian law and is also based on the common coordinating agent model.

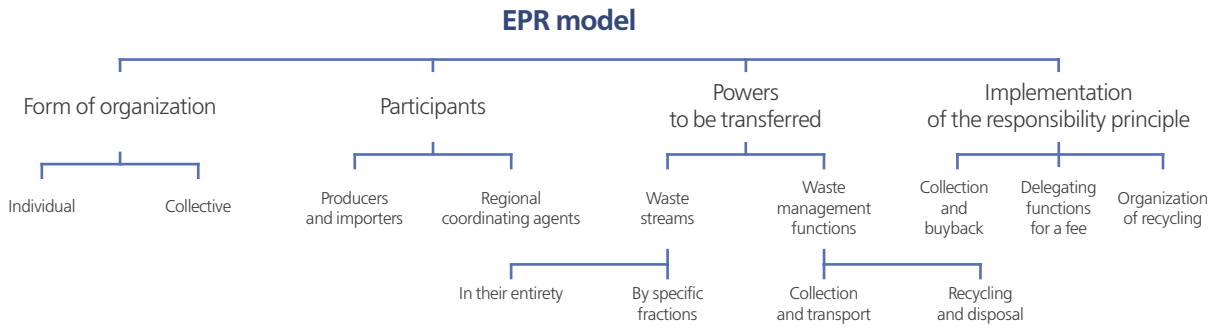
Fig. 15 Organization of waste management with a single coordinating agent and the inclusion of EPR



Source: IFC.

The diversity of EPR arrangements is defined by the various ways in which key characteristics are implemented. A multilayered EPR model is shown in Figure 16.

Fig. 16 Multilayered model for implementing the EPR principle



Source: IFC.

5. Optimal use of PPP types to implement various types of projects in the MSW sector

PPP is a flexible mechanism, which can be adapted to various forms to fulfill specific needs in specific situations. The following types of PPPs may be used in the MSW management sector:

- Service contracts;
- Management contracts;
- Leasing agreements;
- Concession agreements;
- Build-operate-transfer (BOT) agreements;
- Joint ventures.

The types of PPPs differ according to various factors. These include their effective agreement periods, the distribution of ownership rights for infrastructure facilities and the division of responsibilities among partners. Additionally, PPPs distribute institutional, macroeconomic, market-related, investment and operational risks differently. Also, sources of funding and the role of management can vary.

In Figure 17, the ways, in which private sector involvement for various PPP types, are illustrated (from less involvement to more involvement). Table 8 demonstrates how PPPs can have a range of business responsibilities.

Fig. 17 Types of public-private partnerships

Source: IFC.

Recommendations for implementing EPR in Russia

EPR should be introduced in phases, beginning with the most commercially profitable waste fractions.

The most effective way to implement EPR is by launching the program in a series of phases. The first phase should include waste fractions which can be profitably recycled. Packaging waste is particularly profitable and is one of the fastest growing segments of the market.

Since there is an increasing use of packaging, there is an opportunity both to recycle the ever-growing volume of packaging waste and to create packaging from recycled materials. In the EU-12 countries, EPR was first applied for packaging materials and then later to electronic waste, hazardous municipal waste, batteries and storage cells.

For packaging manufacturers using paper, cardboard, plastic, glass and other fractions to make their products, a legal framework should be established to support EPR programs.

A legal framework for EPR should provide for both individual and collective systems. Collective systems can be established via producer associations at the federal level and implemented through regional representative offices. Once this has been accomplished, EPR programs can be extended to other segments as well.

Define waste ownership rights for EPR partners and regional coordinating agents, and establish a record-keeping and reporting system.

The simplest systems should be implemented first. A simple system should consist of either an entire range of waste management services or it can be divided up into collection and transport. In either case, payments should be managed directly. As experience is accumulated, one can expect that constituent entities will use multiple approaches.

Coordinate implementation of EPR at the regional and local levels.

It is essential to coordinate the operation of regional MSW management systems and EPR mechanisms at the regional level. Additionally, regions should help determine how fund-raising mechanisms will function and the scope of services provided. Municipal authorities should define procedures regarding how municipalities will participate in EPR programs when interacting with a coordinating agent.

Table 8. Private partner activities depending on the public-private partnership type in effect

Activities / Type of PPP	Service contract	Management contract	Leasing agreement	Concession/ BOT	Joint venture
Asset management	+	+	+	+	+
Key commercial risks		+	+	+	+
Investments			+	+	+
Asset ownership				+	+

Source: IFC.

The appropriate type of PPP to be used is determined by following the objectives set by local authorities. If the objective is to improve the efficiency and quality of specific services, a service contract will suffice. If the task is to carry out large-scale investment projects, it is appropriate to use a PPP in the form of a concession agreement or a BOT agreement. Table 9 shows how typical MSW management projects are better suited for particular PPP types.

The appropriateness and effectiveness of using a specific type of PPP is determined by several factors: the maturity of the institutional environment, how well-balanced the fee system is and the depth of experience involving the private sector in waste management.

By comprehensively reforming the MSW sector, the PPP mechanism will become more effective. Reforms should improve the organization and coordination of the MSW market, facilitate infrastructure upgrades and encourage implementations of the EPR principle.

By developing a regulatory framework, reforming the fee system for MSW services and collaborating with the private sector, PPP mechanisms can be used to carry out large-scale investment projects for upgrading the MSW management infrastructure. In addition, a PPP can be an effective means of involving importers in EPR programs, so that they can contribute to the construction of infrastructure and the organization of collective recovery systems.

Table 9. Using certain types of public-private partnerships for specific kinds of projects

PPP arrangement	Project examples
Service contract (a private company provides one or more MSW management services)	• MSW collection and haulage; • maintenance and repair of collection and transport infrastructure (for example: garbage-truck maintenance); • operational management of a landfill
Management contract (a private company provides most or all MSW management services)	comprehensive MSW management services: a private company organizes waste collection, transport and disposal, manages landfills, prevents the creation of illegal dumps and fulfills other duties
Leasing agreement (long-term, comprehensive management of a MSW system)	• landfill management and modernization; • management of a sorting complex
Concession/BOT (a private company is entirely responsible for MSW management services, it builds and manages a specific infrastructure facility)	• constructing a landfill; • upgrading an existing landfill (installation of sorting and landfill gas recovery systems); • construction of a garbage recycling plant
Joint venture (a private company and local authorities jointly own the infrastructure facilities)	construction of specific infrastructure facilities (landfills, garbage-recycling plants)

Source: IFC.

Hiring a private, specialized company to both modernize (build) and manage a landfill makes it possible to acquire the expertise needed to construct technologically complex facilities such as gas recovery or filtrate collection systems for landfills.

Non-specialized municipal companies typically lack resources to design and construct complex facilities. Nonetheless, landfills will continue to be owned by municipalities regardless of who may be building or managing them.

Recommendations for stimulating the use of PPP mechanisms in Russia's waste management sector

Develop a federal-level framework of regulations and guidelines for PPPs.

To stimulate the usage of PPP mechanisms for the implementation of waste management projects in Russia, it is necessary to develop a framework of regulations and guidelines that governs the entire range of PPPs. It could consist of either a unique federal law or regulations and guidelines for using PPPs in waste management projects. The federal-level framework of regulations and guidelines must be created at the federal level for implementing various types of PPPs in the regions.

At the regional level: draw up a list of special-purpose PPPs and projects.

At the regional level, it is necessary to draw up a list of PPP types and projects to be implemented under a regional MSW management program. In addition, a procedure should be developed for implementing PPP projects and conducting biddings within the PPP mechanism. The implementation of projects using PPP mechanisms must be overseen at the municipal level.

Stimulate the use of simple types of PPPs during the initial stages of PPP implementation.

When there is no effective legal framework or fee system for PPPs, the use of simple forms of PPPs (with limited participation by the private partner) is advisable.

6. Using data to guide reforms

Government officials, MSW operators and investors need accurate information in order to effectively implement almost every measure proposed in this report. This section describes the additional data that should be gathered and how to organize it.

First and foremost, the following data should be gathered:

- Comprehensive data for all waste management operations (collection, transport, recycling and disposal), including the weight handled at each phase;
- The condition of disposal sites (quantity of disposed waste, waste composition, the residual capacity of landfills and their operability based on projected filling rates);
- The weight of goods (including packaging) removed from use and included in EPR programs;
- The weight of secondary raw materials and supplies along with the quantity of energy generated at recycling facilities that is sent to enterprises and distribution networks;
- Information about the garbage collection and transport infrastructure (number and types of facilities, degree of wear, and the amount of garbage collected and transported).

Two basic information gathering methods are possible:

1. Statistical reporting forms at the level of a municipality, region, coordinating agent or industrial enterprise;
2. A database at the level of a regional coordinating agent that receives information in real time regarding the services that are being provided. The record keeping system can automatically measure the weight of waste that arrives at the landfill in garbage trucks;

Market participants will respond favorably to the new data gathering requirements, since they have an interest in obtaining detailed information. The end result of collecting such data will be an up-to-date waste management map that conveys the physical inventory at each stage of a product's life cycle.

The pace of the sector reform depends on the quality of data that is available. Once enough data is available, conclusions can be drawn about how to improve the MSW management system. In particular, market participants will be able to expand the range and flexibility of their services. Data analysis will also lead to more accurate projections of recycling levels, the inclusion of additional types of waste in the scope of EPR and, as a result, flexible fees for consumers.

Pilot project for the segregated collection of MSW in Murmansk

From January to March 2011, a municipal pilot project was carried out in Murmansk to organize the segregated collection of MSW. In one of the city's districts, 22 garbage containers were set up for the segregated collection of glass, paper and plastic.

After additional manual sorting, the segregated waste was sent for recycling. The cost of the project was 2.7 million rubles. Two million rubles came from the municipal budget and 700,000 rubles were provided by a private investor. The project was implemented in the area with a population of 10,000. However, only 4% of the population participated in it.

The project resulted in the collection of 2 tons of paper, 210 glass bottles, almost 910 kg of glass waste, 157 kg of metals and 50 kg of plastic.

Source: Pashenkova, M. "Separate Garbage Collection in Murmansk Has Failed," Komsomolskaya Pravda, 3 April 2012 [28].

Greenpeace Russia Project: "Interactive Map of Secondary Raw Materials Processing Facilities"

In 2011, Greenpeace Russia launched a project to create a digital map of secondary raw materials processing facilities in the Moscow Region. With the help of volunteers, the processing facilities for secondary raw materials were located and the type of waste they process identified. This information was recorded on the map.

The map currently covers more than 250 collection locations in the Moscow Region along with information on processing facilities in St. Petersburg and Obninsk. The project is expected to be expanded soon: regional maps will be created for Vladivostok, Omsk, Chelyabinsk, Murmansk, Novokuznetsk and other cities.

Source: Greenpeace Russia [29].

7. Raising public awareness

Transforming the MSW market requires not only technological and organizational changes, but also a change in consumer attitudes and behaviors regarding MSW. As a result, publicity campaigns are an important tool for the overall reform of the MSW sector.

Since participants in the waste management system lack sufficient knowledge regarding the waste management system, the effective implementation of new projects is a challenge. If the technical measures proposed in this report are successfully implemented and progressive legislative initiatives are adopted, innovative new projects will be possible.

These innovations will be new to Russia and will require that market participants acquire new knowledge to competently manage and interact with the MSW system. These participants include market operators, legislative and executive authorities at the federal, regional and municipal levels, and the main beneficiaries of the waste management system – households and businesses.

There are four main informational and educational factors that will ensure the success of MSW management programs:

1. Raising general awareness of the impact of waste on the environment and human health;
2. Instilling a caring attitude toward the use of resources and explaining why sorting and recycling waste are beneficial;
3. Providing information about the types of recyclable MSW, the advantages, features and shortcomings of specific waste management methods and the consequences of their use in a specific region or community;
4. Providing information about MSW laws, programs and initiatives, opportunities for obtaining financial support and the procedures for meeting requirements; developing suitable models of consumer behavior in the market as it undergoes reform.

The public at large can be informed with the aid of:

- Media and outdoor advertising;
- Visual information on waste management technologies and methods (as done in other countries and regions);
- Courses and seminars (for educational institutions as well);
- Implementation of pilot programs and demonstration projects.

3.2. Phases and procedures for implementing a sustainable MSW management system

Based on the implementation history of MSW programs in the EU countries from 1995-2008, the time it takes to reach various MSW targets once they are set by law or established as part of a policy is determined by the following factors:

- The development and introduction of new economic and institutional mechanisms at the regional level;
- The pace and scale, at which funds are accrued under newly established mechanisms for financing the sector;
- The amount of private investment;
- The time it takes to attract investments and construct facilities;
- Gaining experience with new approaches and by launching pilot projects (in particular, for some types of waste).

These factors should be considered when creating the MSW management strategy at the federal level and when setting priorities at the regional and municipal levels.

The comprehensive implementation of new mechanisms in the Russian market could last from six to ten years. For example, after Lithuania, Latvia and Estonia adopted packaging laws that regulate the responsibility of producers (EPR) and sellers, it took two to three years to develop the necessary regulations and form associations. Another four to five years were spent to develop the recycling infrastructure.

Three phases are proposed for executing the strategy to overhaul the MSW management system in Russia.

1. **Preparatory phase** (2012 — 2015). Create and implement measures at the federal level that can remove systemic barriers. Such measures include upgrading the statistical reporting system and establishing an informational and educational system. Quantitative targets should be set at the federal and regional levels.
2. **Phased creation of regional waste management systems** (2015 — 2020). Establish the necessary organizations such as coordinating agents and associations. Modernize and construct MSW landfills that are designed according to best international practice. Introduce the segregated collection, sorting and recycling of specific elements of sorted waste.
3. **Final phase for creating the MSW system** (2020 — 2025). Implement all the necessary market mechanisms at the level of regions and municipalities in full. Evaluate the results of these activities and make adjustments as needed. Construct integrated recycling facilities.

This three phase procedure prioritizes the implementation of the least capital-intensive projects that do not require a radical transformation of the market. Such projects include modernizing the basic infrastructure as described in chapter 2 and launching pilot projects in specific regions. As investment mechanisms are put into place, the pace of modernizing capital-intensive infrastructure such as sorting stations and special processing/disposal facilities will accelerate. Beginning in phase 2, as EPR programs and the payment system are established, capital-intensive projects involving a high level of waste recycling will be initiated.

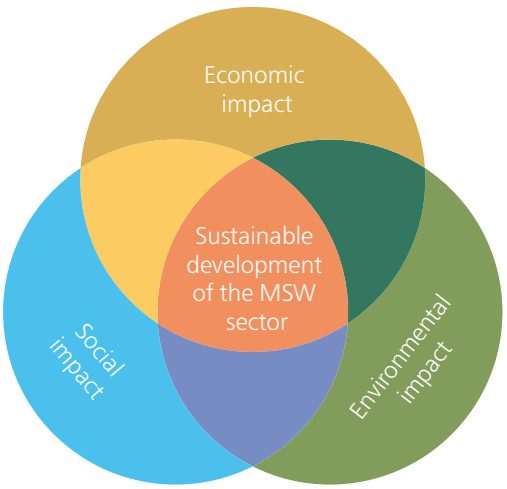
A general description of the strategy's phases, the legislative decisions that must be made and how investment projects should be implemented is provided in Figure 18.

Fig. 18 Phased-in implementation of the strategy

The development targets for the MSW management sector set out in the strategy can be achieved in 10-15 years. To manage the process of improving the MSW system, temporary quantitative and qualitative targets should be linked to legislation at the federal and regional levels. Additionally, a mechanism should be established to monitor and analyze the results of the entire program and to adjust the targets as needed.

3.3. The socio-economic importance of reforming the MSW sector

Fig. 19 Sustainable development of the MSW management sector



Developing the MSW sector in a sustainable fashion can be done by encouraging economic growth while accounting for its effects on society, conserving resources and minimizing environmental stress. A traditional diagram of sustainable development is shown in Figure 19.

The innovation scenario for developing the MSW sector proposed in this report will yield the following economic benefits:

- GRP will grow in absolute terms and per capita as a result of developing the MSW environmental services sector;
- An increase in revenue for regional and local budgets funded by taxing profits and property associated with the waste-sorting and recycling operations that will be created;
- The introduction of low-waste technologies and resource conservation;
- Land can be used for agriculture, construction and recreation instead of MSW management;
- The generation of electricity and heat by using alternative sources of energy.

The social benefits of the innovation scenario will include the following:

- The creation of new jobs;
- Cleaner urban and rural areas;
- A decrease in the rate of illness among the citizenry;
- An increase in awareness;
- Developed respect for nature;
- Enhanced job safety in the MSW sector.

The environmental benefits of the innovation scenario are:

- The prevention of air, groundwater and soil pollution;
- The preservation of biodiversity and the environment;
- A reduction in greenhouse gas emissions, namely landfill gas;
- The conservation of finite sources of energy and an increased use of alternative sources of energy;
- A contribution to greener image of municipalities and constituent entities of the federation, especially near the border.

The model for sustainable development of the MSW sector can be rolled out throughout the economy.

Tons of valuable raw materials and supplies are lost in dumps every year such as paper, glass, metals, and plastic.

These materials account for more than 40 percent of MSW. The absence of recycling amounts to an annual forgone benefit of more than 68 billion RUB.

Conclusions

Main conclusions from the MSW Study:

1. The generation of waste is growing in proportion to rising living standards (GDP per capita). As observed in European countries, the amount of waste generated tends to level off at about 450 kg per person per year. In Russia, as of 2010, the level of waste generated was 330 kg per person. This leaves Russia with an expected future increase in waste generation of 38 percent. Additionally, the share of recyclable fractions relative to the overall quantity of waste increases as living standards rise. Thus, economic growth in Russia is projected to result in an increase in reusable types of waste, such as glass, paper, metals and plastic, making it possible to increase the level of recycling.

2. The current state of the MSW sector in Russia is quite similar to that of the Central and Eastern European countries (the EU-12) 10-15 years ago. If the task is to fundamentally reform the MSW sector in Russia, then the accelerated development trajectory that was executed by the EU-12 should be undertaken, rather than embarking on gradual evolutionary development following the example of more advanced countries of the EU-15. It will take at least 10-15 years to implement new mechanisms for managing the sector, as well as fulfilling the measures put forth in the innovation development scenario.

3. Successful reform of the MSW sector in Russia will require: introduction of a programmatic approach with clearly defined performance targets at the federal and regional levels, monitoring progress in achieving the performance targets and make adjustments as needed, introduction of new economic and institutional mechanisms via legislation and authorization of a single government agency to be responsible for reforming the sector.

4. There are two scenarios for the development of the MSW sector in Russia: a business-as-usual and an innovative. In the business-as-usual scenario, the status quo will continue unabated — recycling will remain at a level of 5-7 percent, while growing amounts of MSW will be disposed of in new and existing landfills. The innovation path of development assumes the introduction of advanced waste-recycling technologies and management models.

5. The attractiveness of recycling for investors depends on the volume of recyclable waste and the public's readiness to bear additional costs. To encourage private investments and garner public support, three regional cluster types have been defined with a unique development path charted out based on the needs of each cluster.

6. By implementing the innovation development scenario at a cost of €38 per person per year, the first group of regions (Moscow and St. Petersburg) will have been able to achieve a 60-70 percent recovery level by 2025. This recovery level will be made possible

by implementing the segregated collection of the widest possible range of waste fractions, launching integrated recycling and recovering energy via incineration. The second group of regions can achieve a 30-40 percent waste recovery level by collecting pre-sorted waste, sorting waste and by recycling. The third group can reach a 10-12 percent recovery level by collecting and recycling mixed waste streams. Innovative scenario ensures that obsolete and overcapacity landfills are closed and remaining non-recyclable waste is safely disposed.

7 There are a number of indirect economic and environmental benefits from developing the MSW sector under the innovation scenario. For example, about 360 million tons of valuable raw materials and supplies that would have been lost will be returned to the economic circulation. The sale of these materials will generate an estimated €26 billion of revenue. Also, an increase in recycling will lower the quantity of waste that is disposed of in landfills, which will reduce greenhouse gas emissions by 267 million tons of CO_2 equivalent. The recovery of landfill gas will generate 5.8 million MWh of electricity and 7.3 million MWh of heat, thereby increasing the proportion of renewable energy sources used in Russia's energy mix.

8 At a time when significant financial resources are needed to operate regional waste management programs and public funding is limited, introducing the EPR principle and the flexible use of PPPs for various kinds of projects will play an important role in the MSW sector. To make PPPs effective several adjustments, introducing economic mechanisms for PPPs implementation, to current legislation is required.

9 Coordinating agents designed to accommodate the needs of specific regions can be established without substantial changes to existing laws. It is only necessary to create regulatory guidelines at the federal level to standardize the creation of coordinating agents in the regions.

10 To monitor the implementation of solutions in the sector and ensure the transparency of the market for all the participants, a centralized database should be established. The database should be designed using government statistical reporting standards that will be based on uniform physical units and compatible with international environmental protection reporting systems.

11 In order for reforms to succeed, it is crucial that various segments of the society provide support. Citizens should acquire an environmentally friendly consciousness and also modify their behavior to benefit the environment. Therefore, it is critical to foster a caring attitude toward resources and the environment in order for reforms to succeed.

Recommendations

The following is recommended for implementing government policies regarding MSW management:

Phase I: 2013 — 2014

1 Adopt a framework for the comprehensive development of a municipal solid waste (MSW) management system and amend the federal law "On the Production and Consumption Waste".[22] The framework and amendments should:

- designate a single government agency to be responsible for the development of the MSW management sector;
- establish performance targets with specific values and deadlines. Also, specify a procedure for monitoring the progress of both reaching the targets and adjusting them as needed;
- government statistical reports on waste should be adjusted in order to track progress achieving performance targets and to track the movement of waste along its life cycle;
- introduce EPR programs, which will include funding mechanisms for recycling reusable waste fractions.

2 Develop an action plan for implementing the development framework of the MSW sector along with requirements for amending the law "On the Production and Consumption Waste". The action plan and requirements should include:

- a new fee system that prioritizes recycling before waste disposal and on the level preceding the following one in accordance with the principle of Lansink's ladder;
- guidelines for developing regional waste management programs that have attainable performance targets and balanced financing (factoring in PPPs and EPR);
- a mechanism for funding waste recycling enterprises on the basis of EPR;
- regulations for the use of PPPs in regional waste management projects and government procurement procedures. The regulations should include incentives for introducing low-waste technologies and prioritizing recycling over disposal;
- the implementation of pilot projects for the environmentally safe disposal of waste in landfills. The landfills should be compliant with best international and Russian requirements. Additionally, remediation projects, landfill gas recovery and recycling systems should be implemented;
- guidelines for new governmental statistical reporting;
- at private sector level, encourage corporate non-financial reporting to include data on related recycling and solid waste management activities;
- create an interactive database covering the best available MSW management technologies and practices;
- launch educational programs covering the consumer aspects of MSW management in kindergartens and schools.

Phase II: 2014 — 2020

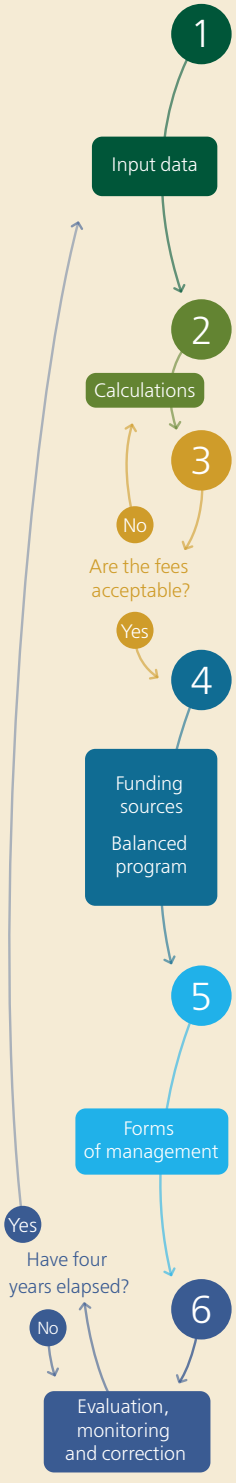
1. Implement the action items listed above
2. Help high-priority regions attract investment
3. Encourage the creation of recycling enterprises
4. Share the best practices occurring at the regional level

[22] According to the terminology of the new amendments to FL No. 89-FZ of 24 June 1998 "On the Production and Consumption Waste."

Phase III: 2020 — 2025

The following sequence of actions is proposed at the level of constituent entities of the federation (see Figure 20 below).

Fig. 20 Developing a regional MSW management program



At the level of constituent entities of the Russian Federation and metropolitan areas with populations of 500,000 or more, a snapshot of MSW is determined based on official and expert data. This snapshot is essentially a balance sheet of waste which shows the amounts of different types of waste that is generated, how much of the waste is recycled and incinerated and how much eventually ends up in landfills. Notably, no waste will end up in unauthorized dumps as this will be prohibited. For metropolitan areas with populations of less than 500,000 (here, developing a snapshot of waste is not viable) and all remaining territories, including the ones discussed above, acceptable waste recycling and disposal technologies are determined. Additionally, the capacity and location of facilities are determined, and closed landfills are slated for rehabilitation.

For all types of metropolitan areas, preliminary costs are calculated and funding sources are identified. Funding sources include investments by private companies via EPR programs, budgetary funds and funds generated from MSW fees. Compliance with national goals is verified and future fee increases are mapped out over the coming years.

Based on the amount of funding available, an MSW system is selected along with recycling and processing technologies. Attainable targets for recycling and other MSW performance indicators are established based on the system/technologies selected. To determine attainable recycling levels that correspond to funding levels and varying fee levels, the model discussed in this report can be used. IFC can assist in calculating the recycling levels if desired.

Within a PPP framework, all funding sources are determined, including borrowed funds. In addition, incentives are provided in order to attract the private sector to the region. Such incentives may include profit tax benefits, government procurement preferences, and a tariff set at a level that offsets investments. A regional program is created for developing the MSW management sector so that it has balanced sources of funding. The type of PPP chosen should be based on the type of project in accordance with this report's recommendations. IFC may provide assistance in creating a specific PPP and attracting foreign investors.

Based on the regional program's structure, a decision is made to introduce one or more coordinating agents, who are responsible for achieving the constituent entity's performance targets. An authorized government body at the level of the constituent entity of the federation shall coordinate the agents' activities and the implementation of the strategy. It shall also monitor the program as a whole and coordinate the creation and operation of a regional database, which includes a landfill registry, a waste cadaster, a balance sheet of waste in general and by type, a compilation of the best technologies and sample documents. The government body shall be also responsible for coordinating processes to keep the public informed.

Regional programs and strategies shall be executed in five year intervals. At the end of each interval, the authorized government body at the level of the constituent entity of the federation shall evaluate results based on the objectives that were set, identify weaknesses and risks, and make adjustments as needed.

Appendix 1
Terms and definitions

Waste

The remnants of raw and other materials, semi-finished products and other items or products that are generated during the process of production or consumption, including goods that are no longer usable for their intended purpose.[23]

Waste management

The collection, accumulation, use, decontamination, transportation and disposal of waste.[24] In the context of this study the term "waste management" is used in a broad sense and does not refer to specific operations involving waste, but rather the overall administration of the waste management system, including its economic, technical and other aspects.

Municipal solid waste (MSW)

Waste generated by households, businesses and organizations. The Russian law does not define MSW. Instead, the term "municipal waste" is used. In effect, municipal waste is all of the waste generated in cities and communities, including commercial-sector waste that has a similar composition to household waste.

Hazardous municipal waste

The portion of MSW containing substances that, even in small quantities, poses a significant hazard to the environment and human health. Hazardous municipal waste may be explosive, flammable, toxic, highly corrosive or carcinogenic. Hazardous waste in MSW includes used batteries, light bulbs that contain mercury, medical waste, household chemicals, glue and paint.

The composition of waste

The morphological composition of MSW. It is determined by the balance of different groups and types of waste —- MSW components — that vary according to their physical and chemical composition, their origin and other factors. The following MSW fractions are typically separated from the main waste stream and sent for reuse or recycling: food waste, paper, cardboard, glass and plastic.

Organic waste (otherwise known as biodegradable waste)

Organic waste is waste that is biologically degradable in aerobic or anaerobic conditions. It typically consists of food waste, household yard waste, wood waste, paper and cardboard. Paper and cardboard are also considered to be packaging waste because of their significant recycling potential.

[23] FL No. 89-FZ of 24 June 1998 "On the Production and Consumption Waste."
[24] Ibidem.

Bulk garbage

Bulk waste that comes from households and the commercial sector and does not include electrical and electronic appliances, namely furniture, certain types of finishing and other interior elements of residential and commercial premises.

Waste from electrical and electronic goods (electronics)

Consists of used and electrical and electronic goods, including refrigerators, computers, telecommunications equipment, washing machines, dishwashers, household appliances and televisions.

Packaging waste

Any products or materials that are used for the storage, protection, transportation, delivery and sale of goods or services and end up as waste. Such products or materials may include glass, plastic bottles, aluminum cans, wooden pallets and plastic packaging.

Appendix 2
Waste management technologies and methods

There are five main ways to process collected waste:

1. The reuse/recycling of waste into raw materials and supplies;
2. The use of waste for the production of organic fertilizers by means of fermentation (composting);
3. The use of waste for heat and electricity generation:
   - Anaerobic digestion to obtain biogas;
   - Direct incineration for recovering heat and electricity. This can also be accomplished at cogeneration plants;
4. Waste decontamination minimizes the environmental impact of hazardous waste in MSW by deactivating hazardous substances using special processes which include controlled incineration;
5. Landfilling is the disposal of waste (both the residue obtained after the processing described in items 1-4 and unprocessed waste) in specially designated areas while applying measures to minimize negative environmental effects.

The waste management approaches described above are examined below according to their priority on Lansink's ladder.

Segregated collection

Segregated collection, an alternative to the traditional mixed collection of MSW, is a necessary preparatory stage for recycling waste. The degree of segregated collection determines the efficacy of the subsequent stages of waste recycling. The simplest segregated collection is sorting the entire waste stream into organic and inorganic fractions. More complex types of segregated collection involve the sorting of inorganic fractions into such categories as paper, glass, plastic, packaging waste, hazardous waste and other waste types.

Segregated collection is done differently depending on the country. Waste may be sorted into specific containers at a special site, or different types of waste may be collected and sorted by residents before it is collected at predetermined times.

The specific configuration of a segregated collection system is determined by population size and density, socio-economic factors, the availability of funding sources and the maturity level of the recycling system.

Considering that segregated collection is organized at the household level, special attention must be focused on informing the public about segregated collection requirements and controlling it.

In Belgium, households collect and sort organic waste, paper, glass, hazardous waste, used electronics and plastic, metal and packaging for beverages.

Recycling waste into secondary raw materials and supplies

Oftentimes, the recycling of waste into secondary raw materials involves basic fractions of MSW such as paper, plastic, metal and glass. The technologies for recycling these fractions are substantially different, so they will be examined individually.

Recycling plastic

Plastic waste is first sorted according to identification codes related to various types of polymers. There are fifty types of plastic. The most common ones are polyethylene terephthalate (PET), polyvinyl chloride (PVC) and finally, high-density polyethylene (HDPE), from which almost all plastic bottles are made. Additionally, plastics may be sorted by color.

The sorted plastic is crushed into small pieces and then purged of non-plastic materials such as labels. After that, the remaining plastic is melted into transportable shapes, which are later used as resources for producing a wide range of products. For example, secondary plastic is used in the production of shopping bags, clothing, sewage pipes and insulated glass units.

Recently, plastic de-polymerization technologies have also been used to decompose plastics into monomers. The monomers are used to fabricate new polymers of the same type as the original plastic. Chemical de-polymerization may also be used. In special cases, when it is difficult to decompose the plastic into constituent types of resins or if there is a high degree of contamination, thermal de-polymerization (pyrolysis, gasification) is conducted to decompose plastics into liquid components. The liquid components may be used as a substitute for newly produced petroleum products.

Recycling paper

Since the technological processes for recycling paper aren't terribly complicated, paper is the easiest waste fraction to recycle. Paper collected by municipalities and private operators is sorted and then any dye or ink is removed. Next, the paper is chopped up and soaked. Then it is ready to be used in a new production process.

Recycling metal

An average of 95 percent less energy is expended when scrap metal is used as a raw material instead of producing new metal. Another plus for reusing metal is that metals retain their inherent properties after recycling. There are two types of scrap metal: ferrous, which includes iron and steel, and nonferrous, which includes aluminum, copper,led, nickel and other metals. Old motor vehicles, ships and railroad tracks are primary sources of ferrous scrap metal. Metal recycling takes place in four stages: collection, pressing, crushing into small pieces and delivery to a plant for reuse. MSW contains a substantial portion of nonferrous metal waste such as aluminum cans and foil, which is collected via a segregated collection system and then melted down.

Recycling Glass

Discarded glassware is sorted by color and crushed into fragments. The crushed glass goes through a multistep procedure to remove iron (using magnetic filters), remove paper and ceramic particles

(automatically and manually) and then the remaining material is melted down. Ceramic particles that become embedded in the crushed glass degrade the quality of glass that is melted down, so special attention is given to the removal of ceramic particles.

Color is then removed from the glass making the material ready for use in production. Recycling glass is beneficial, since glass that is disposed of does not decompose. Also recycled glass does not differ in quality from newly produced glass.

Producing organic fertilizers by fermenting waste

Composting is the biological decomposition of the organic portion of MSW. Composting can be accomplished via aerobic or anaerobic processes. Aerobic composting is easier to accomplish and is thus the most commonly used form of composting.

Composting is used in varying degrees in almost every country, since organic fertilizers can be produced from waste. Composting technologies range from basic household composting to the operation of sophisticated composting facilities.

Importantly, the efficiency of a composting system depends on how it is designed to accommodate different climates, waste compositions and other factors. Table 1 provides a description of the three principal composting technologies in order of increasing complexity. The simplest technology is the windrow system, followed by composting systems in enclosed tanks. The most complex technology is the anaerobic composting system, which uses bacteria to conduct anaerobic digestion. Other forms of composting include individual composting, active pile systems, static pile systems, field composting, the use of waste from dumps and worm composting.

Table 1. Description of composting technologies

Type of technology	Advantages and drawbacks
Composting systems in open windrows	• composting with oxygen present in windrows; • a slow rate of compost formation; the extensive type of composting requires a large amount of space; • the simplest and cheapest method
Composting in closed reactors and cylindrical vessels	• relatively expensive systems; • composting is noticeably faster and more effective compared with windrow composting; • complexity of the system has a negative impact on reliability
Anaerobic digestion	• costly and technologically intricate; • a high rate of fermentation due to the absence of oxygen and the use of controlled biological effects (bacteria)

Source: IFC.

Generating heat and electricity via waste incineration

In Lansink's ladder, incineration has a low priority, ranking only above waste disposal. Nonetheless, waste incineration is a common practice throughout the world, since it substantially reduces the weight and volume of waste and eases demands on MSW landfills by reducing the weight and volume that would end up in landfills by 70 percent and 90 percent, respectively. In addition, the heat produced from incineration can be used to generate electricity.

The main drawbacks of incineration are the destruction of recyclable waste, the need for significant capital and operating expenditures and the need for complex atmospheric emissions purification systems. There are many types of incineration technologies, including simple incineration, pyrolysis, gasification and plasma-based incineration.

The three most common types of energy recovery via waste incineration with generation of heat are shown in Table 2.

Table 2. Waste incineration technologies

Type of technology	Advantages and drawbacks
Mass incineration	• the most common and simplest form of incineration; • an unsorted waste stream is taken from the storage facility and deposited in the furnace, where it is incinerated. Steam is generated thereby activating the turbine of a power generator; • the gases released are purged of nitrogen oxide, mercury and dioxins; the ash is hauled away and buried
Fuel recovered from waste	• a more complex and efficient system; • recyclable fractions are extracted first and the remaining combustible waste is crushed; • the crushed fuel that is generated can be incinerated using the procedure detailed above or added to solid-fuel boilers
Thermal gasification	• a new, uncommon technology; • waste is converted to a synthetic gas (a hydrogen/carbon monoxide mixture), which, when purified, can be used as a fuel

Source: IFC.

Recycling in Belgium

In Belgium, producers are responsible for the recycling of packaging waste which is the principal source of glass, plastic, metal, paper and cardboard in MSW. According to the data from Fost Plus, the national packaging waste recycling organization, 91.5% of 755,000 tons of packaging waste generated in Belgium was recycled in 2010.

Source: FEVE (European Federation of Glass Containers) [30].

Waste decontamination

Hazardous waste consists of flammable, chemically active, toxic or corrosive substances. Examples of hazardous MSW include storage cells, batteries, solvents, light bulbs that contain mercury, oils, cosmetics, fire extinguishers and paint.

Hazardous waste collection is an important part of waste management, since it separates hazardous waste from the overall mass of MSW making the recycling process much easier. The main types of hazardous waste are typically collected separately (batteries, oils).

When managing hazardous waste, environmental damage can be minimized by prioritizing recycling. In addition, unlike all other types of MSW, special attention should be focused on the prevention of hazardous waste generation.

There are two main ways to prevent hazardous waste generation. First, for household products, safe materials should be used instead of hazardous ones. Second, incentives should be provided to encourage households to use products that do not generate hazardous waste.

The recycling of hazardous waste usually includes physical (disassembly, evaporation), chemical (neutralization of active elements, deactivation, and conversion to a solid state) and biological treatments. The non-recyclable elements of hazardous waste are incinerated. Incineration requires special monitoring and purification systems, since carbon dioxide and harmful substances such as dioxins are generated during incineration. Some hazardous waste may be disposed of in landfills while other types of hazardous waste such as medical and flammable waste may not be disposed of in landfills.

When hazardous waste is disposed of in a landfill, it must be separated from other types of waste and placed in a special area specifically designed for hazardous waste. A filtrate-collection and water-prevention system must be used and for the most hazardous types of waste, partial neutralization and chemical transformation should take place.

Electrical and electronic appliances are also considered to be hazardous. They consist of large and small household appliances, computers, lighting, measuring and monitoring equipment, power tools, electric toys and leisure items, medical instruments and vending machines.

This type of waste contains both hazardous substances (e.g., the toxic substances in refrigeration equipment) and valuable materials such as metals. This is why it is advisable to create separate management systems and mechanisms for processing this type of waste. Just like in the case of hazardous waste, the main stages for managing electronic waste are the collection of discarded equipment from the public, sorting and mechanical disassembly, recycling, disposal and incineration.

More than 23% of MSW in Belgium is composted using anaerobic processing. Composting is typically carried out in small-scale installations with a capacity of 20,000-65,000 tons per year. Most installations that do aerobic composting are also designed to extract biogas which is used to generate electricity.
Source: IFC.

About 30% of MSW (150 kg/person/year) is incinerated in Belgium. The incineration is done in large, highly efficient facilities that have the ability to process more than 500,000 tons per year while also generating a substantial amount of energy (48% of energy generated in Belgium comes from renewable sources).

Source: IFC.

The sorting and mechanical disassembly stage includes the separation of hazardous elements and substances such as batteries, light bulbs that contain mercury, and hazardous gases from valuable materials such as computer circuit boards and rare metals. Most of these processes are done by hand. Then the waste is crushed and divided into separate streams of materials such as metals, plastic and rubber. The extracted metals are pre-treated and then melted down. Items that are especially complex such as mobile phones and circuit boards are melted down at specialized enterprises that have systems for dividing and neutralizing hazardous byproducts of the melting process.

It is also important to minimize the damage caused by waste when appliances and equipment are produced. In most cases, manufacturers are responsible for collecting and recycling used appliances in the framework of an EPR program. Such a program provides manufacturers with incentives to consider the costs of processing waste when new products are being developed and also create appliances that have a smaller amount of hazardous substances, which are therefore easier to recycle.

In 2008, the disposal of waste in landfills in Belgium accounted for less than 4% of the total volume of MSW. This is largely attributable to a ban on the disposal of household-generated waste in landfills. Only waste that comes from organizations and is similar to MSW may be disposed of in a landfill.
Source: IFC.

Waste disposal

Disposing of waste is the most ineffective and environmentally hazardous form of waste management. It also happens to be the most common form of waste management. Waste is typically disposed of at three main types of facilities: unmonitored dumps, monitored dumps and landfills that comply with sanitary standards.

Unmonitored dumps are the simplest and cheapest disposal method. On the other hand, sanitary landfills require significant capital expenditures but are the most environmentally safe. Table 3 shows the key characteristics of these disposal types.

Table 3. Principal types of waste disposal and their technological characteristics

Type of technology	Advantages and drawbacks
Open unmonitored dumps	• no pretreatment, disposal plan, disposal monitoring or pressing; • no systems to: prevent filtrate leakage, release landfill gas or monitor the environmental impact **Consequences:** fires, infestations by destructive insects and rodents, soil and air pollution
Monitored dumps	• supervision of waste disposal; • no systems to prevent filtrate leakage or release landfill gas, partial monitoring of the environmental impact **Consequences:** fires, infestations by destructive insects and rodents, soil and air pollution (but in smaller quantities relative to a system with no supervision)
Equipped landfills	• integrated pretreatment, plan for disposal of certain types of waste, disposal supervision, pressing and transfer of waste layers; • availability of filtrate collection and landfill gas recovery systems, integrated monitoring of environmental impact, can be remediated if temporarily shut down **Consequences:** minimal

Source: IFC.

The negative impact of waste disposal includes noise pollution, the spread of dust and unpleasant odors, pest reproduction, fires and other undesirable effects.

The most hazardous consequence of disposal is the pollution of: 1) soil and groundwater as a result of filtrate contamination and 2) the atmosphere as a result of the release of landfill gas. Additionally, filtrate forms when waste comes into contact with rainwater.

The composition of the filtrate is determined by the composition of the waste, the conditions of water penetration and the condition and age of the waste site. The greatest hazard is posed by filtrate containing heavy metals, hazardous chemical substances and liquid that comes from decomposed organic waste. It is important to note that the concentration of organic waste diminishes over time, while the concentration of heavy metals depends on the acidity level of the filtrate.

Aside from filtrate, another powerful pollutant is landfill gas, which is a mixture of methane (35-55 percent), carbon dioxide (up to 45 percent) and water vapor. The landfill gas is formed during the anaerobic decomposition of waste. Depending on the conditions, the gas may also include other components. For example, the disposal of large volumes of gypsum cardboard leads to the formation of hydrogen sulfide. The danger level of landfill gas is in direct proportion to the flammability of the methane in the gas, its toxicity and its potential to negatively affect vegetation.

One ton of waste in a landfill releases an average of 10 m^3 of landfill gas per year. The formation of landfill gas is influenced by the size of the landfill, the composition of the waste, the age of the landfill/waste and the waste storage conditions (for example, density and temperature range).

Landfills can also release small quantities of hazardous organic and inorganic volatile substances into the atmosphere. This small quantity can be no larger than 1 percent of the entire quantity of gas present in a landfill. Mostly these substances are slightly soluble and were either disposed of in the landfill or were formed as a result of chemical and biological processes that took place in the landfill.

Furthermore, waste often includes hazardous components like vinyl chloride, methyl, ethyl mercaptan, sulphureted hydrogen. These components may have a negative impact on human health such as producing carcinogenetic effects, genetic changes, reproductive disorders, negative effects on the immune system and nervous system disorders. These negative effects reduce life expectancy and harm public health.

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Notes

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