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Towards Circular Economy Application: MSW Reform in Russia

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Affidavit

I, **TATIANA CHERNYAVSKAYA**, hereby declare

1. that I am the sole author of the present Master's Thesis, "TOWARDS CIRCULAR ECONOMY APPLICATION: MSW REFORM IN RUSSIA", 90 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted the topic of this Master's Thesis or parts of it in any form for assessment as an examination paper, either in Austria or abroad.

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Abstract

The sustainable use of natural resources became a top priority for countries of the world regardless of their level of development. While our current consumption pattern not only requires two planets Earth, the way it is organized makes it more of a burden. Economic growth, being a measure of success for most governments, has a strong link with resource use and, thus, environment degradation, which needs to be decoupled. Unsustainable production and consumption result in growing volumes of waste.

The main goal of current research is to analyze whether Municipal Solid Waste (MSW) reform (WR) in Russia includes elements to promote circular practices like recycling, moving the country to another, sustainable level of development with a focus on resource efficiency and (circular) materials value preservation. The research was organized to analyze literature on concepts related to efficient use of resources, their role in a circular economy and waste management and, from the practical side, to analyze literature on waste management in Russia and recent changes in it associated with MSW reform.

Analysis of the literature confirmed that the resources of the planet are scarce, and the globally agreed sustainable development path was chosen to decouple economic growth to meet the needs of the growing population to prevent environmental degradation and resource depletion. Circular Economy (CE) could be considered as a concept bringing the economic, social and environmental agenda together, proposing practical approaches to new models of resource use contributing to keeping the value of materials in the economy for longer. Whereas waste management on its own is only a narrow part of the economic cycle where resource management is limited to returning products and materials from the end of life to useful life through proper management and recycling techniques, it is still strongly associated with the CE paradigm. With its WR, Russia is reintroducing the recycling industry as a key element of MSW management which is capable of contributing to the emergence of a CE and its ultimate goal of prolonging material value preservation in the country.

Although current WR in Russia is still at the initial stages, and its reality check shows deficiencies of organizational, financial and educational resources, using best practices from abroad together with local experience represent a good starting point. Still, momentum to build a strong foundation for CE in the country starting from MSW recycling industry is lacking clear linkages and understanding at all levels of government.

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List of Abbreviations

BATs	Best Available Technologies
CAC	Command and Control
CE	Circular Economy
CIWMS	Circular Integrated Waste Management System
EC	European Commission
EP	European Parliament
EPR	Extended Producer Responsibility
EU	European Union
FKKO	Federal Catalog of MSW types
GDP	Gross Domestic Product
GHG	Greenhouse Gases
IRP	International Resources Panel
IEP	Integrated Environmental Permits
LCA	Life Cycle Analysis
MBT	Mechanical Biological Treatment
MDGs	Millennium Development Goals
MFA	Material Flow Analysis
MNR	Ministry of Natural Resources and Ecology
MSs	Member States (of the EU)
MSW	Municipal Solid Waste
MSWMS	MSW Management System
Mt	Million of tones
NEO	National Ecological Operator
NIEF	Negative Impact on Environment Fee
PP	Polluter Pays
PPP	Public Private Partnership
RF	Russian Federation
RO	Regional Operator
SD	Sustainable Development

SDG	Sustainable Development Goal
SMRs	Secondary Material Resources
TSs	Territorial Schemes
UN	United Nations
USSR	Union of Soviet Socialistic Republics
WEEE	Waste Electrical and Electronic Equipment
WMS	Waste Management System
WMP	Waste Management Plan
WR	Waste Reform

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1. Introduction

In the age of global climate and sustainability agreements on the planet Earth, which is also facing unprecedented growth of population, the issue of resource management is becoming more and more critical. Countries' boundaries do not anymore limit value chains, and the wealth of some advanced nations moves production parts of those chains into less developed countries while consumption of those nations is growing unprecedently.

When people can consume more, the issue of saving becomes unimportant, driving the value of resources down. The increase in consumption is strongly correlated with the increase of waste per capita, and it is much higher in rich countries. At the same time when the basic needs of people are satisfied, people start to take care of the environment linking their own behavior with its impact on others, including future generations.

This particular pattern also characterizes nations: when needs of the population are satisfied, demand comes for better conditions of life of the current and future generations, which requires attention to the environment as well as available resources.

Member States of the European Union (EU) are enjoying a high level of life and environment conditions, but it has not always been like this. Individual countries went through periods of industrialization when natural resources were used to cope with the needs of the population to meet the growing demand for goods and jobs, rapid urbanization and shift from agriculture-based to industry-driven economies. The satisfaction of basic economic needs was paid with the high price of environmental degradation and pollution, the cleaning of which took considerable time and resources. Having learned from unfortunate experience, care about people's health and the environment became a top priority and resulted in regional and international agreements pursuing Sustainable Development. Taking into consideration that countries' boundaries do not limit environment and natural resources in the age of global value chains, specific aspects of resource use and environment protection became the subject of a global agenda for countries with different levels of development.

Russia is a country of vast human and natural resources potential. Although its economic growth is not intense, its dependence on abundant natural resources and growing consumption of the population drives the side effect of the growth – waste generation. While high levels of industrial waste and mining byproducts are a particular case of a natural resource-based economy, waste generated by population's consumption – municipal solid waste (MSW) – is also growing. Today, when basic needs of the population are satisfied, and the economy is becoming stronger, Russia is also facing the pressure of the environmental impact of its growth, and it could learn from its western neighbors how to deal with those pressures.

The motivation of my research is driven by a strong signal from the Russian Government to move towards the sustainability path, which was confirmed by the launch of waste reform[1] (WR) in the country and the highest political support it received. Knowing the specific conditions in that country, its economic transition experience and taking into consideration its participation in global environment agreements, my hypothesis is that Russia is moving towards the sustainability path by introducing Circular Economy (CE) practices in the country. It is demonstrated now by the waste management sector.

Thus, the research question I would like to investigate is the following: Is the current WR in Russia in line with CE principles? As the central reflection of CE in waste management is secure material value preservation and minimization of landfilled waste, recycling rates could serve as a proxy to confirm my hypothesis.

Thus, the secondary question would be: What are the technical, economic, political, capacities, and regulatory factors stimulating the circularity path demonstrated by the recycling industry in Russia? Recommendations should be developed on what needs to be done to have recycling as a contribution to the circularity of materials introduced in the country.

[1] Here reference is made to a series of events triggered by the adoption of an Amendment (FZ458) to the Law on Production and Consumption Waste FZ89 in 2014, including restructuring of the waste policy and management system.

2. Methodology

Answering the research questions I have posed requires analyzing different types of literature and concepts, including the concept of resources, their management and place in environment protection, sustainability and sustainable development, as well as the combination of those translated in the concept of CE. The latter is combining the sustainability requirements with a concrete definition of the role of resource use from the economic perspective. This work was done through review of academic and contemporary think tanks literature on all those aspects.

Another block of literature required to answer my research questions is related to waste, its management and regulation. Here a historical perspective was necessary to review as countries on different levels of development see the issue of waste differently, which is driven by financial resources. The review of the literature was covering not only contemporary academic research on best practices in waste management, but also the regulation of this field by developed countries through policies and legislation.

Whereas leaders in CE application are considered to be EU countries and China where circularity regulations have already become part of the legislation, I have focused mostly on EU experience and literature as it is more relevant to the conditions in Russia.

To understand the current situation as well as routes of WR and the recent shift to a CE agenda in Russia, it was necessary to analyze scientific literature on waste management in the country as well as historical preconditions built into management practices of today. A thorough review of legislation development and its practical application for the last decade was also important in order to identify deficiencies and drivers of change in the country.

Taking into consideration that WR is a very recent phenomenon, which was fully launched in January 2019 and still unfolds, it was necessary to review thematic journals publishing expert opinions and analysis of different aspects of the reform. In this regard ad hoc consultations with experts on resource use and waste management both in Russia and abroad were useful so as to have a reality check on the direction of the reform implementation.

A number of assumptions were necessary to take into consideration. First, I assume that CE is a significant approach in the context of sustainable development as it underlines that it is important to look at resource flow from the perspective of efficiency. This is discussed in the first chapters of my work.

Second, it is important to discuss the notions of resource use, CE and waste management (both theoretically and on real examples) taking into consideration the context, part of which is linked to historical developments. Thus, I provide a discussion of the initial conditions for concepts, as well as facts. The latter is particularly important for the analysis of the situation in Russia – a country in transition from a command and control to a market economy.

Third, for the discussion of the situation in Russia I consider the experience of the EU countries as the best reference point. Reasons include geographic proximity, climate similarities, economic linkages and cultural aspects. It is particularly relevant to the Eastern block of the EU due to their common political and economic history.

Fourth, the link between waste management and CE is essential and even sometimes misinterpreted as the only crucial reflection (i.e. CE is seen as a new WM paradigm). My assumption is that economic and technological development initially were supporting production and consumption, while neglecting its negative "by-product" – waste. Thus, I am not only referring to this point throughout my analysis, but also pointing to a tool for the future in Russia to link recycling as a circularity aspect of the WM system with an overall production system (Circular Integrated Waste Management System (CIWMS)).

Combining all the blocks of literature helped to build the analysis of elements and factors of the current reform in Russia and their alignment with the CE principles developed at the international level. It is reflected in the structure of my thesis.

After the introductory chapter, the second chapter of my work reviews the notion of resources, their use as well as scarcity implications for the economy and the environment – with a short review of degradation in most aspects of the environment. Here the issue of the sustainable use of resources is introduced as a driver of international agenda and agreements, including UN Agenda 2030 and its economic-oriented companion – Circular Economy. Further I closely review the role of resource circularity as a translation of material value preservation, echoing previously introduced resource efficiency notions, but now on the bigger scale of national economies. The practical application of CE in the economy is reviewed through models proposed by the concept to "do more with less", preserving value of resources and cutting unnecessary elements like ownership or individual use. Here enabling conditions like collaboration and information exchange, as well as reverse cycles allowing materials returning back into the economy at different stages of their value addition avoiding disposal of waste by all means. Conditions for introducing the CE principle are reviewed with a focus on the concept of reducing, reusing and recycling to retain the value of resources in the economy.

Taking into consideration that the CE discourse is naturally focusing on waste as the most obvious loss which has to be prevented by all means, I review the notion of waste and its typology and treatment options, describing a toolbox for authorities at municipal, regional and state level to shape and evaluate their waste management practices by waste triangle, Ternary Diagram as well as going a step further by connecting waste management systems to production systems as proposed by CIWMS.

Having municipal solid waste (MSW) to narrow down a focus of my research, in the second part of my literature review I am analyzing practices of MSW management, its drivers and organization represented by waste management systems (WMS). This is done in view of the actors and links between them as well as the factors driving their interrelations: financial, organizational and knowledge, as well as technology related.

Waste management (WM) is organized based on national legislation related to environment protection, natural resources preservation, as well as market and business regulation including associated fiscal policies. The concluding part of the literature review provides an example of a state-of-the art MSW management system in Baltic states, an initial stage of WM in which before EU accession is comparable to the current stage of WM in Russia.

The third chapter of this thesis focuses on the application of concepts and findings on resource use through the prism of CE and available WM analysis to the conditions in Russia. I start with a historical overview of the Soviet system of resource management, where circularity was stimulated by command and control measures supporting a strong recycling focus. Further waste management system evolution in Russia is reviewed using legal and regulatory drivers and their application.

This review establishes a context of MSW reform, where I analyze a snapshot of key factors contributing to its implementation, including the legal and regulatory framework, information and knowledge distribution, governance and economic stimulus for WM. Further, the actual reform implementation is reviewed, again, focusing on the key factors bringing recycling into the heart of the reform. Analysis of gaps in the MSW reform is provided in line with review aspects of CE and material value preservation identified in the literature – for instance, the need to support minimization of landfilled waste through improved recycling practices and related enabling conditions. Again, factors shaping the shift of WMS to recycling are singled out, including policy, regulation, financing and knowledge and education issues. The third chapter concludes by analyzing the identified gaps and providing recommendations for a way forward to strengthen the waste recycling industry in Russia.

In chapter 5 I formulate conclusions from my research and identify its significance for further analysis in this field. Here I also define limitations of analysis and possible areas of investigation.

3. Literature Review: Circular Economy and the Role of Waste Management

3.1. Resource Efficiency as a Basis of Sustainable Development

Economic growth is considered to be one of the conditions for meeting the increasing needs of the growing world population with its emerging social and economic problems. At the same time, economic growth could be seen as one of the reasons those problems emerged. It is therefore critical to connect economic growth in the long run with the economic system as a whole operating under the conditions of sustainable development – economic growth should happen in a balance with other systems, including social and environmental.

There's a growing tendency to not only decouple economic growth as a measure of development, but also to consider its absence as a necessary norm. It is seen that it is not the growth itself, but rather its influence on people’s perception of life that is important. Here the index of happiness (NEF, 2012) could serve as an example of measuring life satisfaction as what it includes (e.g. environment impact, life expectancy and level of wellbeing) is considered to contribute to people’s happiness. As an alternative to the economic growth concept, wellbeing is selected as a guiding concept. This approach is particularly important to look at as ensuring economic growth is associated with a number of problems related to the limited resources available on the planet.

Nowadays, economic growth is strongly associated with climate change due to the emissions associated with economic activities and their impacts on the environment. Those impacts from emissions are polluting air, water and soil, and disruption of the ozone layer by specific gases or causing climate change (associated GHGs emissions). The carbon dioxide concentration in the atmosphere is rapidly increasing reaching 1.5 times higher values then it was 200 years ago before the industrial revolution. Atmospheric concentrations of methane increased 2 times and the same increase is seen for nitrogen oxide (EPA, 2016). Thus, one of the key resources necessary for human’s life on the Earth, air, is becoming scarce and its renewal is under threat.

Pollution of fresh waters, seas and coastal waters causes shortage of clean drinking water as well as lack of water for industrial and agricultural needs and depletion of the oceans – the latter being an important regulating force of atmospheric processes as well as biological life on land and in the air, which is now under threat due to acidity levels (SRC, 2015).

At the same time, the biosphere and lithosphere are also being destroyed by economic activities, the latter being exploited through extraction and processing of raw materials necessary to have final products by the industry – one of the major pollution sources. Current production activities are not sustainable. Already in 2008 unused domestic extraction comprised about 40%, meaning that materials were extracted, but not actually used in the production process (OECD, 2013). Those materials are ending up being waste.

One more issue is related to deforestation, as reduction of forest cover leads to imbalance of oxygen in the atmosphere, which influences life on earth. The associated biodiversity is under threat and shrinking. So far, as a result of economic activity 60% of biodiversity was lost irreversibly (WWF, 2018).

The increasing resource scarcity coupled with growth of the population influences the living conditions of people. Numbers show that major demographic changes occurred in the twentieth century, including growth from 1.65 billion inhabitants in the year 1900 quadrupling to more than 7 billion people by the end of the century (Roser et al., 2019).

The use of technologies and the emergence of new ones on the cross-roads of knowledge fields, including bio, nano and other technologies without proper assessment of their impact is another contributing factor. Some technologies are associated with the production, transportation and use of toxic materials and chemicals, which are also becoming waste after a short life span, contributing to the transfer of hazardous elements back to the environment and even being exported to developing countries in the form of waste.

All the above aspects associated with economic growth are related to the natural need to improve the living conditions of populations, to meet increased living standards through mass production. The linear model of production which was introduced by the industrial revolution in the 19th century does not work anymore to support environmental, social and, thus, sustainable economic conditions as it creates a deficit of natural resources, increases social inequality and pollutes the environment. Globally the finite carrying capacity of the planet was surpassed. (UNEP, 2011 and 2012). It is particularly noticeable in the last two decades when both the use of natural resources and associated discharged wastes are showing unprecedented growth. Currently the world consumes about 1.7 times what the Earth can sustainably provide and absorb in the long run (WWF, 2018).

"*The link between human wellbeing and economic development on the one hand and the use of natural resources and environmental impacts on the other hand needs to be broken introducing a notion of decoupling."*(Van Berkel, 2018). The International Resources Panel (IRP) promotes the need to decouple the impact of economic development and resource consumption from environmental degradation (UNEP, 2011). Efficient use of resources is also supported in the process of transition to a CE (UNIDO, 2017) as its ultimate goal is to keep the value of materials in the economy as long as possible.

Sustainable Use of Resources

The notion of resource efficiency as such is used for different aspects (Ekins and Hughes, 2016) according to the IRP. It includes not only the technical efficiency of resource use measured by the useful energy or material output per unit of their input, but also by the resource productivity. At the same time, it is also showing the extent to which resource extraction and use negatively impacts the environment. Increasing the efficiency of resource use would benefit the environment making the pressures lower. Using resources less intensively is actually increasing productivity of resources, decreasing the resource use per unit of production. Use of environment is directly linked to the use of resources and, thus, associated to value added through pressure on the environment. According to the IRP (ibid.), efficient use of resources is essential for meeting the Sustainable Development Goals[2] (SDGs) with fewer costs. It can also contribute to economic growth and job creation keeping the resource flows available. Production activities by industries are also relevant to climate issues (UNIDO, 2010).

In particular, resource efficiency provides opportunities for low carbon innovation in operations, processes, products and services as well as production and consumption systems at large. It involves five approaches contributing to that, namely: dematerialization of products; increasing process efficiency; minimizing process emissions; switching to low carbon inputs; and closing carbon loops (see Figure 1).

[2] A UN-consensus based plan for Sustainable Development Agenda till 2030.

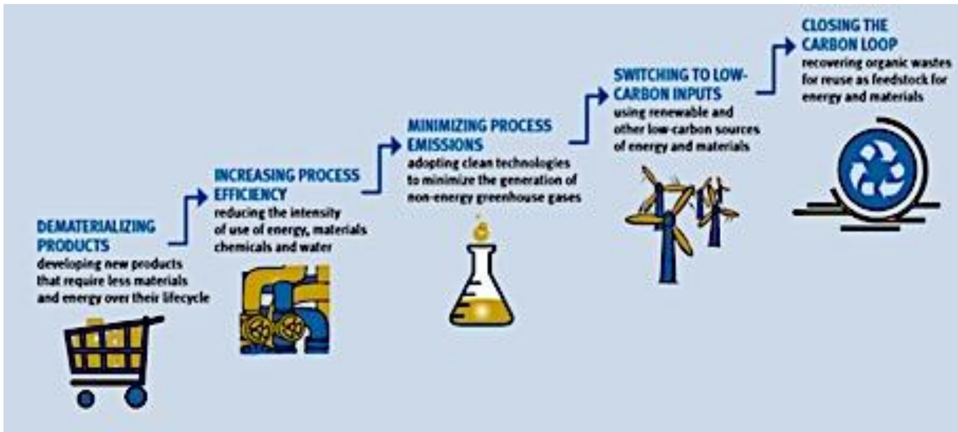

Figure 1. Resource efficiency for low carbon innovation (UNIDO, 2010)

The estimated size of the economic opportunity provided by resource efficiency is USD 2.9 trillion (McKinsey Global Institute, 2011) to be achieved by 2030 based on known and proven options of water, energy, land and steel use. Only using the 15 key opportunities identified for efficient use of resources, 75% of the global economic opportunity could be reached. Those key opportunities include simple measures of efficient energy use in buildings, efficient irrigation and end-use of steel.

Most of the available economic potential (70% to 85%) is located in developing countries. Using resources efficiently serves as a stepping stone to achieving CE as it assumes identification of use of resources from extraction to design, production and, eventually, consumption of different products. In turn, CE itself is expected to be able to contribute to global GDP growth of USD 4.5 trillion by 2030 while enhancing the resilience of the global economy (Ekins and Hughes, 2016), which represents 37.5% of the estimated total economic opportunity of the SDGs (BSDC, 2017).

Path to Sustainable Development Agenda

It is important to specify what is considered to be sustainable development and how it is defined before embarking on further discussion of CE contribution to it. Sustainable development includes three key interconnected criteria: meeting the needs of the present generation; ability of future generations to meet their own needs; ability of each person to develop freely in a well-balanced society and in harmony with the environment.

Those aspects were initially discussed in the Club of Rome in 1971 in a report “The Limits to Growth”. Further, in 1972, a strategy for SD was created at the first World Summit on Environmental Problems held in Stockholm. Next, in 1987, the Brundtland Commission (formerly known as the World Environment and Development Commission, WCED) formulated the concept of SD in the report “Our Common Future” as “meeting the needs of the current generation without compromising the ability of future generations to meet their needs” (Thomsen, 2013).

In 1992, in Rio de Janeiro, the United Nations Third World Summit adopted a constituent text of 27 principles (UN, 1993) of the “Rio Declaration on Environment and Development” containing the main provisions, including the main objective of sustainable development being the satisfaction of human needs and aspirations together with meeting the most vital needs of all people. Later, in 1995, different SD indicators (SDIs) (UN, 2007) reflecting the interrelation between areas of sustainable development (environmental, economic and social) were developed to include the influence of the environment on the economy and vice versa.

The better the state of the environment, the easier it would be for people to deal with the economy as more resources would be available. At the same time, more production activities contributing to the economy will have a greater impact on the environment through, for instance, pollution, natural capital decrease and waste creation. Further, the concept of sustainable development was contributing to different international discussions and formulation of advanced measurement and monitoring tools for its implementation tracking resulting in the adoption of the Millennium Development Goals (MDGs) before the turn of Millennium and, fifteen years later, the SDGs.

Adopted in 2015, the United Nations SDGs until 2030, while guiding the transition to SD, also specified the urgent need to change the traditional linear model of the world economy operating according to the “get, use, throw away” principle, to a new sustainable model of circular or closed cycle economy (Ellen MacArthur Foundation, 2016).

Circular Economy: Definition and Principles

CE aims at changing the classic linear production model by focusing on products and services that minimize waste and pollution associated with production. The basic approaches of a closed-cycle (circular) economy include the renewal of material resources, processing of secondary raw materials and transition from fossil fuels to the renewable energy use. It is also considered as a part of the fourth Industrial Revolution (Pakhomova et al., 2017), which is also expected to increase the rational use of resources, make the economy more transparent and predictable as well as contribute to its rapid and systematic development. As was the case of resource efficiency impact described above, the transition to a CE requires modernization and innovations based on dematerialization, increasing the life cycle of goods and materials they are comprised of, contributing to remanufacturing, reuse, repair as well as consumption, processing and use of parts to produce new products.

Monetary benefits of the CE for GDP growth and job creation, for instance, make the application of this concept attractive to countries. A favorable legislative, tax and institutional environment is created by the governments of different countries to support the circular economy around the globe. In particular, the EU has adopted a plan of action for the transition to a CE. This plan provides that such a model becomes the basis of the EU sustainable development strategy and involves the development of appropriate state regulations (EC, 2015).

Transition economies like Russia are also considering the transfer to the circular model, although the country is not so advanced yet. However, in January 2018 the Industry Development Strategy for the Treatment, Recycling and Disposal of Production and Consumption Waste till 2030 (waste strategy) was approved. It has contributed to shaping a new branch of industry in the country stimulating additional resources to be involved in the secondary circulation. This in turn contributes to reducing the volume of industrial and municipal waste and their harmful impact on the environment.

While discussion about defining CE and its application is still ongoing and some scholars (Reike et al., 2018) even track research on the evolution of CE concept to the Edo Era in Japan or Quesnay's "Tableau Economque" published in 1785, still, its modern concept is routed in developments of the last half of the century. It could be divided into three phases across which the issue of resource saving remains the central one. In fact the whole discussion started with pollution limitation through end of pipe solutions at the end of 1970s and focus on waste management to regulate landfills and incineration.

Model of CE started to be mentioned in 1976 in the research published later (Stahel and Reday, 1981) addressing the issue of longer use of products and remanufacturing of waste. Further contribution to CE discourse was made by the theories of industrial ecology in 1990s in the National Academy of Engineering of the USA. This tendency prevailed till the 1990s when the issue of eco-efficiency (through design) became more popular connecting output and input (including cleaner production and industrial ecology concepts). In 2002 "cradle to cradle" principle was proposed (McDonough and Braungart, 2002). And only around year 2010 the CE discussion started to be shaped by the "*threats to survival of the human race in the light of (...) sustainability challenges*" linked to "*population growth and renewed attention for resource depletion and retaining the value of resources*"(ibid.).

The current discussion on CE is shaped significantly by the work of the Ellen MacArthur Foundation developed by McKinsey & Company in the report published in 2012 (Ellen MacArthur Foundation, 2012). It stipulates "*three main principles of CE*:

- *design out waste and pollution;*
- *keep products and materials in use;*
- *and regenerate natural systems*."

They support decoupling economic growth from the natural resources degradation through creating innovative products, services, business models and state policy (FCEI, 2013). The latter should limit consumption, decrease losses of natural resources, thus limiting waste.

In general, CE has to replace the linear economic model. Its principles contain previous work on CE, including the 3R approach and emphasize the need to link producers and consumers as well as to create systems of data exchange among participants of economic processes. Some concrete business models demonstrating transition from the linear to a circular economy are already in use.

Models of a Circular Economy

A number of CE business models emerged in response to resource efficiency agenda. They could be used both individually and in combination (Accenture, 2014). The most common models are described in Box 1.

Box 1. Selected Models of Circular Economy

- Circular supplies - a model in which limited resources are replaced with fully renewable sources. It includes "use of renewable energy and other recyclable input material to replace single-lifecycle inputs".
- Product life extension - a model that allows to save economic benefits of a product as long as possible through "repair, upgrading or reselling". This model also assumes replacing physical products with actual benefits (services) they provide to the customer.
- Exchange and joint consumption (sharing economy) - a model that is based on the exchange of goods or assets that have a small utilization factor to address ownership and use separately. Examples of common use platforms for such consumption are transport (Blablacar), housing (Airbnb) etc.
- Product as a service - a model in which customers use products by "renting" goods using pay-after-use "to internalize benefits of circular resource productivity". One of such approaches is known as chemical leasing, where not a product as such (chemicals), but rather its service is paid for by the customer (see www.chemicalleasing.org for details) organized by a service contract.
- Recovery and recycling of resources - a model that uses technological innovation and opportunities for recovery and reuse of resources. Examples of such model include a closed-loop recycling involving use of waste as a new resource.

Looking at those business models one can conclude that reuse and recycling are among the most important elements driving circularity in the economy. One of the CE definitions even describes it as "*a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops (...) [which] can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling*" (Reike et al., 2018, p.249).

Apart from practical applications described in business models, there are other building blocks (Ellen MacArthur, 2017) supporting the CE. Those include design of products, enablers and favorable system conditions (e.g. political agenda and collaboration between stakeholders) as well as reverse cycles (to decrease leakage of materials from the economic circle). The latter two are of interest for the purposes of my research as they directly address the use of resources and associated regulations and will be further discussed in this chapter.

Enabling CE Conditions

Changing the traditional linear approach to the use of resources into circular practice with materials reuse and focus on resource productivity should be supported by educated political and media forces. The five enablers identified (ibid.) for those include leading by example and collaboration.

While the CE agenda introduced by economic needs of individual companies was further analyzed by researchers and scholars since the late 1980s and included into national policies of selected countries (FLG, 1994), it has reached the highest political discourse only almost three decades later. For the first time at the international level it was voiced by the Prime Minister of Japan at the G8 Summit in 2004 as a three R principle – 3R: reduce, reuse and recycle (see Box 2 for details) (Ministry of the Environment, 2005). His proposal was supported by the leaders of other participating countries as a new G8 initiative, shaped later into the G7 Alliance for Resource Efficiency – here, the example of Japan spelled out at a high level led to collaboration of G7 countries on resource efficiency and 3R.

Box 2. From 3R to 5 (and beyond) R: Introduction of Value Retention Options

The 3R principle assumes *reduced* consumption and waste, while products are *reused* and *recycled* to the extent possible. Its goal is a model of society where all resources (including materials, energy and water) are used so efficiently that the notion of "waste" is no longer necessary. It also leads to introducing the concept of zero waste[1] when maximally sorted out into recyclable fractions waste is recycled (producing secondary material resources – keeping their value and reintroducing them back into the economic system) and its recyclable part is treated thermally or incinerated (producing secondary energy resources, again, back into the system). Still, one should remember the state of reaching zero waste as a result of recycling is non-reachable due to laws of thermodynamics, thus even after incineration ashes require landfilling.

In addition to the three Rs, there were other two Rs introduced to include other aspects into the concept's implementation. Technology was considered not only for safety of using household and industrial wastes and increasing the recycling potential of secondary resources as such, but also to improve the efficiency of technologies used throughout the whole value chain starting from extraction of raw materials, their transportation, actual production of goods and, eventually, their consumption and return into the cycle rather than disposal as waste. Those technologies require additional considerations for new *design and thinking* behind the processes. Both adding to 3R principle as *Redesign* and *Rethink* making way for the discussion of 5Rs[1]. Those two Rs are crucial for the introduction of the circular economy as they are considering the very beginning of the entrance of virgin (as well as secondary) resources into the circle allowing to plan keeping the materials in it for as long as possible. More detailed descriptions of redesign and rethink approaches are provided below.

The principle of *Redesign* includes the need to use innovative technologies to create new products already at their development stage. This allows to consider future recycling, reuse and minimization of the environmental impact of the product already at the stage of its design. Some global corporations like Coca Cola, Mars and Toyota are already using this trend supported by researchers like those from the Cradle to Cradle Innovation Institute. The latter as a non-profit organization provides inputs to ensure full circular product design[1] through Cradle to Cradle Certified standard for products corresponding to criteria and requirements for continuous improvement by developers and manufacturers in the composition and technology of their products.

Public consciousness and awareness, so called environmental mindset, are also important for the global outlook and the taking up of circularity principles for economy. Consumers drive producers' behavior not only by selecting more economically attractive goods, but also by reducing of or even abstaining from consumption of goods which are not environmentally friendly. It is the basis of the *Rethink* principle, which is receiving increasing attention in many countries around the world. The main focus of this principle is on educational programs for children and young people as they represent future generations' consumer choices, although adults are also considered as a target audience for the consumption of today.

At the end, the 3R principle could be extended to the 5R principle to absorb the above additional principles and to cover the whole cycle of product transition with a focus on waste minimization and the actors involved in it (producers and consumers). Some scholars go beyond the 5Rs bringing other value retention options doubling the number of Rs, adding notions of refuse, repair, refurbish, remanufacture and repurpose to the list (Reike et al., 2017).

Led by the example of political dialogue at the global level among the G8 leaders has been further spelled out in individual countries and regions in the form of 3R-based strategies and initiatives, most commonly known of which is the EU's Circular Economy Package (EC, 2015) including its EU action plan for the circular economy (EC, 2018) published in 2015. Of course there have been other similar initiatives introduced before and after in individual European countries (e.g. Germany and the Netherlands) (EEA, 2015; BMWI, 2010; Bastein et al., 2013) and other regions of the world, including China (Zhu et al., 2018), Japan (mostly related to Material Flow Analysis, MFA and lean production initiatives) and the USA (RIT, 2018). Selected elements of CE were also used in some countries to change policies and practices to decrease the environmental impact of economic growth and secure resources. Good examples set by national experiences are used in collaborative platforms for benchmarking and replication.

It is important to mention that there is still no consensus (Prieto-Sandoval et al., 2018) on the circular economy concept as a way to attain sustainable development, which is confirmed by over one hundred (a still growing number) definitions of CE available (Kirchherr et al., 2017). Thus, the interpretation of the concept and its application to specific areas of existing economic systems lies within the governments' individual domain and the need to address the most burning needs of economic development and environment protection in the national agenda. The main goal of my analysis is to link elements of CE with the new regulations and policies of the Russian Government in the domain of resource use and, specifically, management of waste and to identify how those elements are aligned with CE agenda.

Reversing the Cycles

For the purposes of the current analysis the reverse cycles proposed as one of the building blocks (MacArthur Foundation, 2017) of the CE are of particular interest. They (ibid.) assume "*the final return of materials to the soil or back into the industrial production system*". In order to understand this statement more clearly, a version of a CE diagram is provided below in the circular economy knowledge map comparing different models of resource use (see Figure 2.).

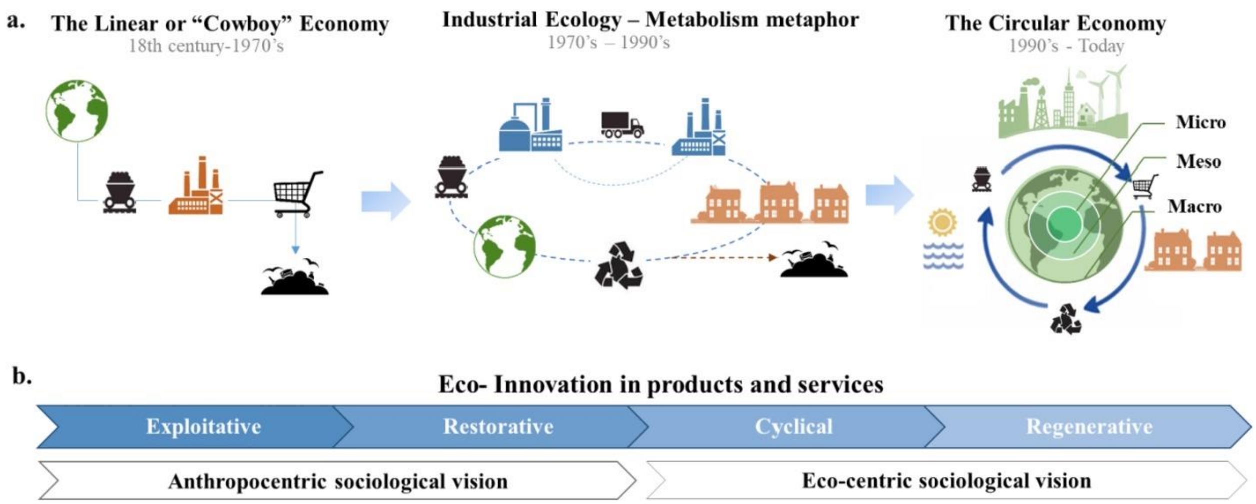

Figure 2. CE knowledge map (Prieto-Sandoval et al., 2018)

The map shows the transition of production activities from linear to circular practices in time and in line with emerging eco-innovation approaches and visions. The movement of resources in the linear and industrial metabolism cases has an indication of resources becoming waste, whereas in the CE diagram it is assumed that all resources are remaining in the system to be reused while changing their status from waste to resource (as a byproduct, or secondary resource after treatment of waste). This is a visual demonstration of the reverse cycles building block of the CE concept.

Analysis of the literature (ibid.) also confirms that eco-centric innovation vision of consumers and suppliers in the circular model drives "*environmental practices, paving the way towards CE implementation*", as use of advanced waste collection practices mitigates unsustainable use of natural resources. The demand side of CE diagram comprised of transformation, distribution and use of resources and products, reflects "*the constant changes in market trends and customer preferences and [should be] managed by firms that use CE strategies such as for waste management (...)*". The latter being defined by the Council of Logistics Management (Jamshidi, 2011) as the "*term often used to refer to the role of logistics in recycling, waste disposal, and management of hazardous materials; (…) in source reduction, recycling, substitution, reuse of materials, and disposal*". To conclude: reversing the cycles assumes revision of different skills and knowledge areas to allow materials contained in waste back into the economy at its different value addition stages, as the content of waste in itself often includes raw materials which could be used by other industries.

While it is clear that policies and practices of CE are aiming at economic growth while reducing use of resources by retaining value of materials, the concept of SD is strongly related to this goal in the broader context of fulfilling the needs of future generations. In the next chapter I will outline concrete interrelations between the two to further explore and analyze the place of waste management systems in those concepts.

3.2. Aligning to CE Principles: Waste as a Resource

Economy as a system of organizations and institutions supporting human activities and interactions in production and distribution of resources remains a backbone of the SDG framework serving as a platform for the Inclusive Growth with Safe Operating Space (UN, 2015). It brings together issues of industrialization and sustainable consumption, for instance.

Materials play a crucial role in the economy as the basis of meeting human needs while creating value of resources along the production chain from the extraction of virgin materials to the end of a product life. Life cycle analysis (LCA) of materials could track the product value, which is added gradually along the production chain, peaking at the point of sale to the final consumer and then being lost together with useful properties till a product becomes waste. The goal of CE contributing to SD is to keep that value as long as possible in the economy loop without letting it out as waste. While this could be considered at any stage of product development, including material extraction, product design and use, the focus of my analysis is the end of a product life, transition to its “grave” in LCA terms – waste.

It is clear that in the current economic system waste is considered to be a final stage of a product's existence. In fact, a product’s value is dropping dramatically when the interest of its consumers is lost. Still, users’ interest is not always about the loss of useful properties of a product (especially when products are complex and relatively long lasting – electronics, clothes or even glass jars etc.) as there are many other factors influencing the decision to abandon the product. Sometimes it is more about availability of more attractive alternatives which allow satisfying the needs of a consumer. However, the product which loses its value for one customer could still be valuable for another. Also, materials contained in the product and their value could be retained and routed back into use with comparably high value.

Levels of consumption are determined both by income levels of individuals and, thus, their demand, as well as the level of industrial development, and goods’ availability to satisfy that demand. Consumption is characterized by the duration of retention of materials as useful objects and the properties of goods considered as waste. Before the industrial revolution, waste consisted predominantly of organic fraction, which could have been composted and used in agriculture. Increased welfare and industrialization had an impact on waste composition, shifting it towards more inorganic content. This, in turn, makes more complex the ways of dealing with products after their useful life – the waste itself.

Waste Treatment: Value Retention of Materials

Regulation of waste management is the responsibility of authorities as growth of population and settlements has contributed to the desirability of centralized waste management to meet the growing health, environment and aesthetic needs. Knowing what is contained in waste and distinguishing between its useful (and usable) and non-usable fractions in view of material value is important. Thus, monitoring waste morphology and making treatment decisions based on waste content is essential both for the quality and quantity parameters, as well as options to choose for collection, reuse and treatment of waste. One should define what is waste as well as its types, as value retention techniques are determined by those definitions and, thus, set the boundaries for further analysis (see Box 3).

Box 3. Waste definition and typology

The word "waste" is defined by the Cambridge Dictionary as "*unwanted matter or material of any type, especially what is left after useful substances or parts have been removed*". This definition represents the direct meaning useful for the purposes of my research. It could be further extended to all the substances or products resulting from the process of production and consumption and which have lost their initial characteristics as a result of industrial processing as well as/or moral and/or physical deterioration. At the same time, waste in the framework of CE discussion is almost non-existent. Figure 2 shows that in an ideal world there is no waste in the circular approach to the economy as any waste should be rather addressed as a resource contributing to another production process or energy creation. Nevertheless, different reasons are driving waste management practices, which could relate to the social, economic, environmental and political spheres. Whereas in the least developed countries waste management is still associated with health issues, in the developed countries it is 'taken for granted' no longer being a major driver (Wilson, 2007) as the discourse has already moved to efficient management of resources.

All waste could be divided into production waste (solid industrial waste or SIW) and consumption waste (municipal solid waste or MSW). Regardless of the fact that MSW comprises only up to 10% of overall waste, it is the most difficult to treat. MSW represents non-used solid substances resulting from vital activities of people as well as amortization of houseware. The sources could include residential and non-residential buildings, commercial, sport and other enterprises. Composition of MSW includes the secondary material resources (SMRs), biodegradable (organic) waste and non-processable waste. The former being clearly the most attractive source of commercially driven waste recycling. Categories of wastes included into SMRs range from highly liquid (e.g. industrial waste, including metals and high-quality paper waste) to medium, low- and non-liquid materials (e.g. laminated paper and paper meat packaging).

MSW is heterogeneous and has many components, which makes its management and treatment complicated, especially if there is no initial sorting or treatment organized. The qualitative and quantitative composition of waste also depends on the production technology, initial composition of the products as well as consumption methods used. Those parameters determine waste management practice to be applied, also taking into consideration physical, chemical and biological properties of waste.

The composition of waste is determined by its fractions, the value of which depends on the options available to extend the useful life of materials contained in it. For example, organic waste could not be considered for long recycling chains as its use is determined by the speed of its transformation into components, which could be used for different purposes (such as composting). Other fractions of MSW specifically are paper and cardboard; packaging waste; glass; textiles and electronic appliances etc. Initial sorting of those fractions at the source also depends on collection options, which, in turn, influence the separation.

The focus of current research is on MSW as it is also the focus of the WR of the Russian Government, which I am going to analyze in further chapters. One of the critical factors of MSW collection is satisfaction of waste producers (inhabitants and organizations) with the proposed practice of sorting and collecting as it also contributes to their willingness to participate in collection schemes. This, in turn, influences the rates of recovered material in the overall recyclable amounts as well as the quality and quantity of those separately collected materials. Moreover, the success of waste sorting programs depends not only on inhabitants' behavior and the proposed infrastructure for collection and treatment, but also on offered recycling programs and their economic incentives, socio-economic differences among households themselves, as well as convenience and availability of collection infrastructure and techniques.

One can conclude that MSW sorting, either at the source or as an alternative (mechanical) separation of mixed waste, is the step towards defining the destiny of collected waste. Once it is collected in monostreams with distinguishable value based on properties of contained materials and in view of their known supply quantities, decisions on further treatment options could be made. It is important to note that mechanical separation of mixed (i.e. not separated at the source) waste conducted using the process of mechanical biological treatment (MBT) could not retain the value of materials making the recycling rates lower or even completely abolishing the option to retain the material value[3].

Assessing the MSW practices from the value retention point of view, decisions should be taken on the collection and treatment as both are influencing the costs of overall management activities as well as their acceptability by the citizens in terms of economic and service values. An overall framework should be proposed by the government for assessing municipal solid waste and the value retention of its materials. Decision making on WM should take into consideration the environmental outcome of waste treatment as well as the technical feasibility and economic viability to realize the proposed options. Those decisions should be well informed from the side of all stakeholders, adding the dimension of social acceptability.

MSWM Assessment Toolbox

Taking into consideration a multidimensional reality for making choices on waste management at the municipal and national level as well as the need to keep that shift to CE requires to see waste as a resource, there are a number of tools which could assist in this regard. The first tool to assist municipalities in balancing their choices between the key parameters is called a waste triangle (Reuter et al., 2005). It allows assessing costs, performance, environmental impact and users' satisfaction (waste triangle) when creating an efficient management system for MSW.

[3] The reason is that MBT is resulting in outputs which are composted (for the organic content) or incinerated (for the non-organic part) and ultimately landfilled. Also compost generated by the treatment of organic fraction at the MBT is not suitable for agricultural needs, thus, those materials are also inevitably transition to the landfills (as a cover material or as landfilled waste).

At the national level, when a country (or a region in the country) needs to benchmark its performance against the set targets for MSW management, a Ternary Diagram (Pomberger et al., 2017) could be used to evaluate approximation to specified goals and its dynamics over time.

Responding to the issue of combining waste prevention policies and materials value retention practices promoted by the CE concept requires the combination of the MSW management system with a broader economic system including manufacturing and use phases of materials as products. This approximation could be introduced using CIWMS (Cobo et al., 2017) as a tool to track the life cycle of a product from the raw materials extraction stage through several iterations within a circle of 3R and waste until the landfilling.

All three tools are described in detail in Annex I showing the complexity of WM practices application due to sensitivities of the field. In the next chapter, I will look at the waste management drivers and practices applied based on a WM system approach. The role of the state in this sector is essential as the issue is sensitive from economic (resource), environmental and social point of view. This role is reflected in regulations and policies, the development and application of which will also be reviewed in the next chapter.

3.3. Drivers of Effective Waste Management

Technological progress allowed humanity to achieve relevant independence from nature and to improve the quality of life of people. At the same time this progress required significant resources to be used to meet the needs of individuals and most of the time those resources are used inefficiently, returning back into nature in the form of waste, diversity of which is increasing with the level of progress achieved. Modifications of raw materials for production processes could even result in hazardous waste which is becoming a threat for human health and existence. The share of useful product in the amount of overall raw resources and materials consumption does not exceed 8% returning 92% of the used substances back into the environment in the form of waste. It is estimated that about one fifth of the raw materials extracted worldwide will become 12 billion tons of waste per year (OECD, 2013).

For example, in the pulp and paper industry of Russia only 27.3 tons of paper are produced out from 1,000 m3 of wood (weight is determined by the density of resource used), whereas in Sweden the same amount of wood is used for production of 129 tons of paper, in the USA it is resulting in 137 tons and in Finland 164 tons (Kharlamova, 2018). This data shows that the volume of resource used for production of paper in different countries is different reflecting the productivity factor per ton of paper, which depends on many parameters, including the technologies used and the quality of the raw materials among others. Still, the difference is striking and the fact that there is no certainty about the way the remaining raw materials are used (average paper yield in Europe ranges from 47% to 61% of paper from provided wood (Soliman et al., 2017)), those materials could be considered as waste at least for the paper production industry. Thus, for the purposes of the study, waste and elements of waste management will be defined as a basis for further discussion on drivers and policies of governance in this area.

Currently mitigation of pollution from most economic activities is supported by application of so called end of pipe technologies in all sectors, including agriculture, industrial production and energy. Those technologies are dealing with the creation of waste at the end of value chains - the least desirable outcome in the context of resource scarcity contradicting the global sustainable development agenda. After defining waste in the previous chapter, concepts of waste generation and management will be discussed, focusing on its governance and options available to make those practices sustainable.

Definition and Practice of Waste Management

Waste management is a complex industrial process which includes several steps, namely collection, sorting, transportation, processing or reprocessing, warehousing and safe storage. Special management practices should be applied to ensure the main aims of waste management – protection of population and the environment, as well as conservation of resources. Waste hierarchy, a tool allowing the waste management goals to be reached, specifying WM practices in order of preference (Figure 3).

Figure 3. General Waste Hierarchy According to EU Waste Framework Directive (ISWA, 2013)

The main focus of a successful waste management strategy is the prevention of waste, whereas disposal and even recycling are among the least preferred. Waste prevention practices are known and rapidly developing especially because of the recent resource efficiency concerns as well as the move towards the CE concept by many countries. It is particularly relevant to industrialized countries where the volume of waste per capita is higher due to levels of consumption. Still, practices of waste disposal (landfilling) and recovery are used wider in conservative and less advanced societies. Those less preferred practices include deposition (burial) in specifically equipped landfills; composting and thermal processing (direct combustion of unsorted and/or sorted waste with possible energy generation; pyrolysis and gasification of the organic part of the waste; plasma recycling of unsorted waste; sorting and subsequent burning of the organic components for energy generation purposes.)

While the composition of waste plays a crucial role in selecting its treatment, choosing incineration is "*... the most affordable and one of the most economically viable* [ways to treat waste and to get simultaneously] *renewable energy sources.* [as] *The average cost of obtaining electricity at such a power plant is ten times lower than on the sun, and more than two times lower than on the wind* "(Tugov, 2015).

The composition of waste also influences the costs of treatment as well as the number of stages of treatment, as some wastes by definition contain hazardous substances (like medical equipment) or highly toxic industrial waste, which might require additional decontamination stages to be applied. Thus, waste classification is required to determine the different approaches to its treatment. Unfortunately, those classifications vary in different countries according to the risk for human exposure and to the environment. However, there are attempts to create homogeneous listings understandable at least across the neighboring state borders and in the regions. Those, in particular, are included into the Basel Convention (Basel Convention, 1989) on the Control of Transboundary Transportation and Disposal of Hazardous Wastes (applied by 170 countries). There hazardous wastes are divided into nine main classes with sub-classification indicating the hazardous properties of the waste. Still, some countries preserve their ways of internal waste classification.

After discussing the notion of waste, complexity of its classification and preferred management practices, the principles of creating systems of waste management as well as their functionality will be introduced. This would allow discussing issues of governing such systems, which is strongly connected to the methods of waste valorization and regulation policy.

Waste Management System

Waste management is a reactive rather than proactive phenomenon. Historically, waste management was not a priority, especially before the first human settlements were organized and waste which was produced as a result of people's activities became visible. Thus, one could say that transformation of lifestyles from nomadic to sedentary is the first driver for waste management. Growth of cities and their population, which was suffering from health-threatening pollution led to the creation of specific rules and measures directed towards minimizing harm related to waste. It took people centuries to link some health consequences with actual waste, but in many cases simple measures of waste concentration and removal were critical for solving the problems.

The first visible wastes which were attended to were liquid and gaseous (industrial pollution of water and air) and, thus, the first regulations were mostly related to their treatment and limitations. Solid waste seemed to be less of an issue as it could have been accumulated and removed, buried outside of the settlements without considering any treatment at all. Unfortunately, those practices were in place as their consequences like pollution of ground waters or soil were not visible and immediate. Thus, while accumulating contamination, with time waste was becoming even more dangerous for human health. Centuries of such experience contributed to the establishment of measures and regulations which, coupled with the actors involved in waste generation, consumption and management, gradually transformed into waste management systems.

The most rapid development of a WM system is associated with the second half of the 20th century when industrialization and economic development were already at the level which allowed people to be more aware of other aspects of life than economic growth and survival. The following stages of development of WMS can be distinguished: allocation of waste in small dumps in the 1970s resulted later in construction of landfills – engineering structures with sewage filtering treatment and biogas utilization systems; as of the 1980s a system for separate collection of MSW was developing, creating a market for secondary raw materials; in the 1990s the processing of solid waste with the release of the organic component and its subsequent composting was introduced – a modern scheme for processing MSW with sorting of waste to separate valuable (secondary raw) materials and the organic (for composting) as well as solid (to be incinerated or landfilled) fractions.

Developing a WMS assumes that all sources of waste and their consumers are the objects of management, control of which is based on the following drivers:

- creating conditions for reducing the amount of waste;
- ensuring the growth of waste use;
- supporting environmentally safe conditions for waste storage and disposal.

WMS Actors

Any system of waste management consists of three parts: collection of wastes, their transportation and treatment, and overall control over all those processes. This system does not exist in isolation as it is based on already existing systems of human settlement organization and functioning. It results from outcomes of other systems, including the production and consumption systems, which comprise the overall socio-economic system. Waste management is an integral part of overall management of that system. Thus, the structure, responsibilities, methods, procedures and processes in WM system should be coordinated with the management of other activities (industrial production, health management and others) and it must also be included in the system of environmental management as a whole.

A WMS is comprised of various actors (consumers, producers, recycling organizations etc.) as key players and support institutions (manufacturers, mining industries, waste management authorities etc.) operating under specific conditions (social, economic, ecological and political). Like any system, WMS is characterized by interactions among its actors and institutions while they are all reaching their own goals.

Those interactions take place at different levels or between different stakeholders. Resources involved in the interaction between elements of the WMS are the key, although the objectives of the actors might vary. Thus, informing all the actors about the main goal of the system, which is the reduction of residues, wastes and emissions while maintaining the quality of materials throughout their life cycle, creates a shared vision among the actors contributing to achieving the goal of WMS more effectively.

Society should be widely involved in solving issues of waste management as one of the key benefiting stakeholders. Other stakeholders include authorities, non-governmental organizations, waste-related control agencies, representatives of waste treatment enterprises and landfills, transportation companies, secondary materials treatment organizations as well as media. Only having all the groups involved will ensure transparency of management as well as clarity about the necessary steps, taking all the interests into consideration. Still, the main work should be done by environment experts who should report to a group of representatives of all stakeholders on the state of the system and needs, as well as measures and next steps to be done.

WMS Financing

In order for both the producer and the population (consumers) to have incentives to reduce waste generation, it is necessary to link the payments with the actual amount of waste. Such a scheme can work effectively with the use of administrative and penalty measures simultaneously, as well as in combination with other methods of the integrated system (Cherp, 1996).

Key drivers of economic regulation of waste management are:

1. Waste prevention and decrease through implementation of low-waste and non-waste technologies as well as using the wastes created during production processes.
2. Fees for waste landfilling/placing.
3. Economic stimulus of waste management activities.

Financial support to the implementation of proper MSW Management (MSWM) Systems is particularly important in a world with rising material consumption and, thus, waste generation. Unequal economic development of countries is reflected in management approaches, as focusing on waste prevention is not possible in countries with lower GDP per capita. Even if policies preventing landfilling are motivated by lack of space, still, the first goal of WM is a priority: concentration on human and environment security. In this regard, another driver for MSWM support is valorization of waste. Not only some components of MSW, according to their structure, are by definition categorized as secondary materials, but also substances (like, for example, phosphorous, which is essential for metabolism of plants) contained in some wastes are valuable. This factor also drives a financial stream into the management system adding up to the state and/or municipal budgets, which are usually dedicated to this issue.

Transition from landfilling of MSW to a 50% - 60% or even 90% processing of it is the main goal of the most advanced countries. Still, it is a luxury which is not available even for most developed countries, as waste processing is associated with large capital investment; therefore the construction of industrial waste processing facilities around the world is rather slow.

Organizational and Knowledge Factors

The basis of efficient reduction of landfilled waste is that its fractions should not be mixed. But whereas a combination of several activities can contribute to this solution there is no single technology which could solve it and there is no single approach which could be applied equally across different regions of the world.

For each specific region, a choice of a particular combination of approaches is necessary, taking into account local experience and resources. The plan of measures in the WMS should be based on the study of the waste flows generated in different sectors of production and consumption, assessing options available and conducting small pilot studies that collect information gaining the experience in defining the best ways of treating waste. Those experiences and accumulated knowledge could be translated into regulations and laws supporting efficient WMS and, again, reinforcing benefits of reducing waste generation and separating its usable fractions for reuse and recycling, thereby reducing landfilling.

At the same time, WMS should be organized in such a way that it has the ability to adapt to changing conditions in the economic and technological sphere, that is, to evolve and improve together with changes in management approaches and materials processing methods. The conditions for its self-development include elements of flexibility, mobility and consistency that ensure the use of results and previous experience. Using the current trend of resource management in view of WMS becomes more and more important in this regard. Analytical tools on concentration of resources in production and consumption systems contribute to developing strategies to maintain resource quality and the value of materials throughout their life cycle even at the waste stage. A comprehensive material flow analysis (Rechberger and Brunner, 2001) could be employed to address root causes for material losses in MSW to plan and implement better resource management strategies.

The WMS requires a set of organizational, regulatory, technical and economic means to support its monitoring, implementing improvements and developing new technologies. Continuous information support, data availability and training of experts on waste management is required for smooth implementation. In some countries, automated data banks have been developed to track certain types of waste as the lack of a unified system of collection and storage of information makes difficult operating a WMS.

WMS Support Instruments

Apart from the main goals of waste management driving creation and operation of a MSWM system, there are a number of instruments which contribute to compensate for the lack of financing for those systems, especially in less developed countries. Those include (1) Extended Producer (and Importer) Responsibility or EPR, (2) implementation of the "polluter pays" principle as well as (3) introducing waste hierarchy as such.

The latter is widely used as a basis for developing strategies on waste management (EC, 2016) as it covers the key principles and provides guidance for waste reprocessing, reuse as well as recycling, all together contributing to waste minimization. Description of the first two instruments is provided in Box 4 below.

Box 4. Instruments for WM Costs Allocation

Polluter Pays

Polluter pays principle (PP) was first recommended by the OECD in 1972 as an economic principle for allocating the costs of pollution control, including the costs of pollution prevention and control, related administrative measures, damage and even accidental pollution. Whereas it "*become identified with the principle of full internalization of the external costs of pollution.*"(OECD, 1992), it was further accepted by the international community at the Rio Summit in 1992 (UNESCO,1992) .

Nowadays PP Principle is understood in a broader sense covering not only pollution prevention and control measures, but also liability for damage to the environment and pollution at the source (including product impacts, life cycle assessment (LCA) and even EPR). It does not only cover the actual damage, but also includes precautionary measures minimizing the risk, which could be borne by a polluter. Whereas this principle is not yet considered as a general principle of law, most countries have introduced it into their national legislation and it is widely referred to in different international environmental agreements. Instruments of its implementation are widely used to support national MSWM systems and include command-and-control measures (including standards, emission limit values and best available techniques (BATs)), economic instruments (taxes, labels and specific rules) as well as voluntary approaches (so called "soft laws") (Joseph, 2014).

EPR

In the market economy, priority must be given to economic incentives and stimulus methods. At present, waste producers do not bear the full economic and social burden as it is shifted to the society. Therefore, a system of Extended Producer Responsibility (EPR) was proposed to make sure that a waste producer compensates the public costs of waste management. EPR serves as a measure which encourages the manufacturers to introduce technologies that reduce waste generation. It is a driver to financially support WMS which are mostly relying on state budget and lack resources to operate.

According to the OECD definition, EPR is "*an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle*" (OECD, 2001). This practice allows internalization of environmental externalities by producers while they consider their product utilization and impact along its life cycle. In the EU, "as such, EPR is to be considered as a major instrument in support of the implementation of the European Waste Hierarchy" (DG Environment, 2014) contributing to hierarchy implementation through producer action on collecting, taking back used goods as well as for sorting and treating them for recycling. EPR is started to be used widely since late 80s by different countries, including developing economies, as its implementation was promoted through specialized technical assistance programs of developing agencies, including UN Environment and UNIDO. This work is also part of SDG 12 "Sustainable Production and Consumption".

Existing EPR schemes include work with different waste streams like batteries, waste electrical and electronic equipment (WEEE), packaging, end of life vehicles (ELV), tires, graphic paper, oils, medical waste, agricultural film and others. Some or all of those schemes are introduced in majority of EU-28 countries to certain extent. Other countries introducing it globally include the USA and Canada (where it is implemented at provincial level); some LAC region countries like Argentina, Brazil, and Mexico, as well as Asian (more advanced in Japan and the Republic and Korea) and even to some extent in selected African countries (OECD, 2014).[1]

3.4. Regulation of Waste Management to address Circularity

The state is forced to use different methods to engage population to introduce waste management practices. Those include both carrots and sticks methods, although the more efficient are the ones that create conditions to encourage conscious participation rather than forcing it. Other regulation practices include punishment for rules violation.

Historically developments contributed to creating a range of regulations including legislation, directives as well as economic and regulatory instruments. The latter are important for efficient management of resources and, ultimately, wastes in an environmentally friendly manner.

Development of waste regulation is strongly connected to overall national regulation system. While main goals of waste treatment are at the very center of the waste legislation, the path they are introduced into the concrete rules and laws differs even according to the general legislative practices: bottom up approach in common law development could be contrasted with top down civil law practices in the US and European systems respectively. In general regulatory discourse on MSW management is closely related to one of resource efficiency (Johnson, 2014) as it has transited from "traditional" in this field legislation protecting human health and environment to the preventing waste and recovering materials it contains.

Whereas national legislation has its nuances, it still refers to international law and, in particular, international customary rule associated with international agreements and statements like the one included in Principle 2 of the Rio Declaration regarding state's own natural resources as well as the principle related to concept of *preventing pollution*. Other international level legislation includes reference to the *precautionary principle* applied when not enough evidence of hazard is available (Ibid.). There are also international multilateral treaties related to waste regulation: the London Convention as well as Basel Convention. Key EU waste legislation is provided in the Box 5 below.

Box 5. Key EU waste legislation

In all 28 European states waste legislation follows a policy of shared competences between the Union (represented by it legislative bodies) and the Members States rooted in the Treaty of Lisbon objective to work for the sustainable development of Europe. The environmental policy of the EU is based on the Article 191 of the Treaty on the Functioning of the EU (TFEU) aiming "to preserve, protect and improve the quality of the environment and to protect human health". Further legislation includes the European parliaments and of the Council directives (for example, Waste Framework Directive, 2008; Waste Incineration Directive, 2000; Directive on packaging and packaging waste, 1994; Waste electrical and electronic equipment, 2012; Waste batteries and accumulators, 2006 and Industrial emissions, 2010) and regulations (on animal by-products no intended for human consumption, 2002 and Waste statistics, 2002); EC Communication on waste and by-products (2007) and Council Directive on the landfill of waste (2000) (MWE, 2019). Examples of legislation confirm the development of an overall umbrella framework and, subsequently, individual industries guidance also reflecting the need to accumulate statistics to properly inform decision making at the national and supranational levels.

At the national level in civil law ruled States, waste management legislation is usually guided by a national level environment protection and public health legislation with subgroup of waste-related regulations. Some aspects of environmental rights are even included into State Constitutions followed by specific Acts and Ordinances related to waste management and individual industries (packaging in particular).

The regulation approaches of the command and control (CAC) nature are most commonly used, whereas economic incentives are becoming increasingly important. Among the CAC approach polluters are usually prescribed to follow certain standards, including ambient quality standards; emission or discharge standards, process and product standards and their combinations. Whereas the CAC approaches have specific advantages based on experiences of regulations application in other fields and existing regulatory structures and institutions in use, still a number of disadvantages of those approaches are there related to lack effective enforcement, negotiation nature of regulations between public authorities and the private sector contributing to corruption risk. Other shortcomings of such regulations include their rigidity and costs associated to their enforcement.

Economic instruments of waste management regulation are considered to be more efficient as they "*provide market signals in the form of modification of relative prices (e.g. taxation on certain products) and/or a financial transfer (payment of a change)*."(Barde, 1994) There are seven types of economic instruments, including emission charges or taxes; user charges; product charges or taxes; administrative charges; marketable (tradeable) permits; deposit-refund systems and subsidies. Most of those economic instruments are directly applicable to waste management and, importantly, contribute to revenue raising for environmental protection and monitoring activities.

Practical implementation of reviewed regulatory frameworks as the ones which set framework for waste management system operations will be considered in the next chapters of current research.

3.5. Practices of Waste Management in the Context of the Circular Economy

There are similarities between waste management practice which could be reflected in common-ground solutions proposed to solve problems in both developed and developing countries (i..e. low- and middle-income countries). Still, contexts of developing countries are different and characterized by issues never experienced by developed countries, including "*rapid urbanization, soaring inequality and the struggle for economic growth; varying economic,* *cultural, socio-economic and political landscapes; governance, institutional and responsibility issues; and international influences, [creating] technical and non-technical challenges of immense complexity...*" (Singh et al., 2014). Thus, nowadays WM practices are also different and although references from the developed countries could be made as examples of best practice, those are not necessarily applicable as such to the conditions of developing countries.

Nevertheless, there is progress in MSW management, common grounds of which are related to basics goals of WM - health and environment protection and improved resource efficiency, whereas recently those goals are started to be accompanied by climate change, institutional capacity and increased public awareness and participation drivers (Wilson, 2007). This progress is demonstrated by the figure 4 below.

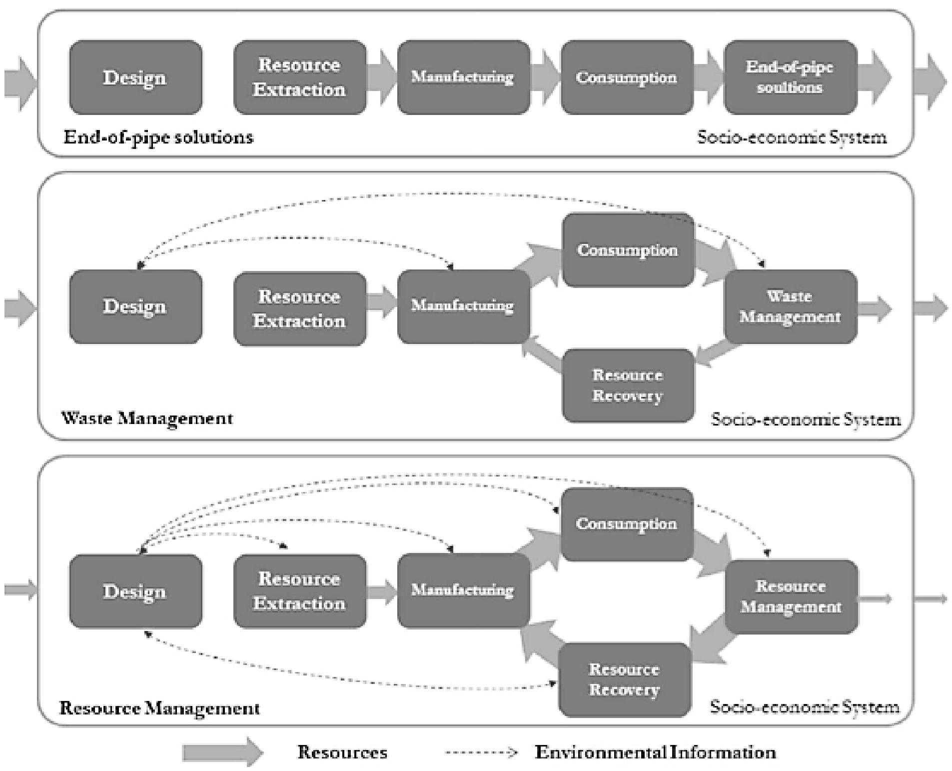

Figure 4. Developments in resource management – from 'end-of-pipe' approaches to more systems-oriented approaches (Singh et al., 2014).

Taking into consideration that the goal of my research is to identify whether current change of regulation and practices in MSW of Russia is in line with material value retention focus promoted by the Circular Economy, examples of comparable practices in MSW management from the countries with similar backgrounds, level of consumption and composition of MSW should be used. Those countries include Eastern members of the EU, MSW practices of which is provided below.

Based on the overarching review of national municipal waste management systems in the selected countries in Europe (Malinauskaite et al., 2017), the EU targets transformation of waste management into sustainable material management embedding the principles of the circular economy (EP, 2017). Being at the top of the EU agenda, CE is still interpreted and implemented differently by its individual member states (MSs), which is reflected in their individual practices in approaching WMS from the CE perspective. Still, one common clarification which could help in further guidance from the EU side is related to "*establishing harmonized provisions related to the end-of-waste status to certain type of waste, at least for aggregates, paper, glass, metal, tires and textiles.*" (ibid) and calculation rules. Overall goal of EU in moving towards CE is particularly related to loss of 57% of the municipal waste generated in the Union as it is either incinerated or landfilled. Taking into consideration average waste generation of about 477 kg[4] per each of its 512 million inhabitants, specific targets were established along with other proposals to revise waste legislation focusing on material value retention.

According to the preparatory work to meeting the new targets and adopting new legislation at the national levels, waste management planning became one of the key tools obliging the authorities to establish one or more waste management plans (WMP) to follow the amended Waste Framework Directive. The established plans should be accompanied by related waste preventing programs to be implemented by MSs according to their individual conditions, which could still be clustered according to the geographic location, which reflects to some extent groups of similar European countries. Thus, in the Central and Eastern European region and the Baltic states in particular, the very first national waste management plans were aiming at closing old dumps and rebuilding new landfills as well as to create facilities and infrastructure for recycling and composting to meet EU standards. As discussed in the Box 6 below, further development of waste management systems in the three Baltic states are now targeting waste prevention and recycling.

[4] Smallest amount of waste per capita being annually generated in Poland (with estimate of 282 kg in 2015).

Box 6. CE practices of MSW in Baltic States

The main governmental bodies responsible for waste management policy in Baltic states are Ministries of Environment, which implement the EU legislation into national laws and envisage its practical enforcement. At the same time, local authorities are in charge of collection, transportation, recovery, and disposal of MSW on their administrative territories. I.e. organization of MSW management is conducted at national and local levels. While Estonia and Latvia are characterized by waste generation rate below EU average, Lithuania's ranges are considered medium, although landfilling in this country is still the main waste disposal option (55% of the total waste is landfilled) in contrast to 30% in Latvia and "largely reduced" landfilled wastes in Estonia mainly due to Waste to Energy (WtE) practices. The latter being an additional source of income for the national economy of Estonia as it imports waste for energy recovery from Ireland and Finland. Recycling practices in that region improved in Estonia, although reaching with uneven progress among regions as waste streams are also diverted to WtE largely increased in Estonia in recent years although contributed to some overcapacity. In Latvia only ¼ of waste is recycled and very small very small amounts of waste is sent to MBT. In Lithuania the recycling is improving diverting ⅓ of waste from landfilling or still negligible energy recovering practices, although the latter are considered as the main option to waste treatment in the country, which triples its WtE capacity in the nearest future to also meet its decreasing exports of waste.

Other elements of making MSW practices more circular include introduction of a landfilling tax by Estonia in 1990 and, more importantly, a ban on landfilling unsorted MSW "with basic requirements to the municipalities to organize source separation of paper and cardboard, green garden waste and hazardous waste, as well as packaging waste, through the public collection system." (Malinauskaite et al., 2017). The National Waste Management Plan (NWMP) gives priority to separate biodegradable waste (BW) from mixed MW also suggesting separate collection of garden waste in cities. Key contribution to the recycling progress especially in Estonia was organized using EU and domestic funds by municipalities to build about 100 collection points across the country for recyclables and other wastes collection, including hazardous waste and electrical and electronic equipment. City strategy of the capital city Tallinn also contributed to 53% rates of separation in 2012, the third in the EU. Latvia also introducing prevention of waste generation as the key priority of the current National WMP further exploring waste as a resource while reducing the landfilled waste. Creation of WM Systems for different regions of Lithuania accompanied with MWM rules contributes to CE promotion, although landfilling is still considered the cheapest (and thus most economically favorable) option for waste treatment. In Lithuania, purchase of containers for collecting secondary raw materials distributing to municipalities is considered a step forward to increase recycling.

All countries are exploring EPR schemes especially on packaging waste as successfully confirmed by the only operator of Estonia's deposit refund scheme contributing to its ambition to meet the EU's 2020 target to recycle at least half of four key household waste streams (glass, metal, paper and plastic). Latvia is benefiting from natural resource tax in promoting EPR and, thus, collection schemes for some waste types, including WEEE, batteries, end-of-life vehicles, packaging.

It is important to note that EU structural and investment funds are used for waste management projects, including construction of MBTs, remediation of old landfills/dump-sites, construction of bulky waste collection and green waste composting sites, extension of separate waste collection systems as well as "further development of the separate collection of waste, modernization of capacities to prepare waste for recycling, reuse, or other recovery (sorting lines, other equipment) and modernization of the waste management information system and monitoring."(Ibid)

Among the key *barriers* to aligning MSW practices to circularity promoted by CE concept in Eastern Europe the following could be named:

- unavailability of the data of recycling packaging waste from producer responsibility schemes and their systematic update;
- uncertainty with regard to MBT as only actual amount of recycled material recovered there is included into allocation and, thus, reported to Eurostat;

- lack of cooperation of private operators of EPR schemes as well as
- competences and resources of authorities to fulfil their waste management responsibilities; and
- lack of local government cooperation.

The *recommendations* to improve circularity-oriented approaches in waste management practices are:

- creation of supportive institutional framework and necessary infrastructure to improve the WMS performance;
- increase in landfill taxes to phase-out landfilling of recyclable and recoverable waste;
- good cooperation between public and private sectors;
- strengthening information systems supporting monitoring of environmental impacts of waste sites and
- reliable WM data collection.

Some other country-specific recommendations include: fulfilling targets for biodegradable waste diversion from landfills; including packaging waste into reporting to Eurostat on the recycling of MSW distinguishing the households packaging from those produced by industries, as well as properly organizing oversight of waste management in some municipalities to reduce recyclable waste sent by its operation companies to landfills.

To summarize, one could make a *list of factors* helping to shift MSW system to enable circularity practices. Those include *organizational, political and regulatory, economic (and infrastructure), technological and knowledge (and educational)* factors supporting the transformation. Evaluation of MSW management in Russia will be done using those factors.

4. Resource and Waste Management in Russia

4.1. Historical excursus on resource and waste management in Russia

The State, business and the population are the three parties concerned by the issue of waste treatment. Those three parties in different modifications also comprise a system of relationships in the social and economic life of a country. Their role is different and they have different approaches to and weight in building an effective waste management system. Nevertheless, the state plays in this system a role of a regulator and sometimes even a service provider with control and monitoring functions.

Regardless of the vastness of the country and the abundance of natural resources, their efficient use was always in the loop at the highest level. 3R-kind of practices and closed loop recycling and reuse were widely promoted in Soviet time. Sadly, it was mostly goods deficit that contributed to products life extension and use of sharing business models. The deficiencies of the centrally planned economy were creating what has now became a global agenda – an economy where the first two principles of CE were used, although of course one could not see there elements of regenerative natural systems and the roots of those practices were different.

Russia nonetheless has a heritage which could be used to create CE under market conditions after having some elements of it in place in a command and control economy for more than 70 years. Analysis of those options in view of circularity and sustainability trends in the world is at the heart of current research. Still, a snapshot of waste treatment practices used beforehand and now in the Russian Federation will be done first to see the departure point to promoting elements of circularity in the waste management system as a goal to shift to overall CE model of economy.

Historically in Russia the state was always the main actor involved in waste issues. Even in the year 1564 when the very first state paper factory used secondary raw material (cloth) for paper production, already in 1714 Peter the Great brought that initiative under the State regulation issuing a Decree on cloth collection in Petersburg region with established purchase price as well as monitoring the collection volumes (Rustrana, 2007) . Later, in 1720, he signed a Decree stimulating paper collection.

After the Socialist Revolution in 1917 collection and use of secondary resources was organized by state and non-state organizations, which was stimulated by more than 100 decrees issued by Lenin (Soviet Decrees, 1917), encouraging the rational use of raw materials and resources, including secondary materials. Box 7 contains information on state organizations responsible for resource management in the USSR.

Box 7. Resource management system in the USSR

State organizations dedicated to the topic were established already in 1923 under supervision of People's commissar on procurement (Narkomsnab) of the USSR and, later - to the State Planning Commission of the USSR. A separate Head Office "Souzglavvtorresursy" (Union's main secondary resources organization) was established under the USSR State Committee on Material and Technical Supply (Gossnab) in mid 50s and, in 1980, it became one of the main departments under Gossnab, which was operational till 1988. Activities of those organizations were translated by 1979 into operation of around 1092 collection points-shops of secondary raw materials. (Bukrinskaya and Myasnikova, 2018)

The overall policy was managed at the central level by the system of Gossnab, which had its own resources, as well as a developed system of specialized organizations. It was operating in close collaboration with enterprises to which it was at the same time supplying those materials and technologies. Collection of data and its analysis was formalized and organized on the basis of detailed statistical reporting in general and on different categories of waste and their qualitative and quantitative parameters in particular (including mining and mineral processing waste as well as consumption and production waste).

Management decisions were well informed through that channel and this was reflected in development of state (Union-wide) and sectoral programs for secondary resources in close consultation with planning and norms of waste collection and recycling. Implementation of those programs was also supported by wide infrastructure of collection and industrial treatment of secondary resources. State as a leader in price formation for production was taking into consideration high costs of collection and treatment of waste.

The All-Union Research Design and Technological Institute of Secondary Resources of Gossnab was created for this purpose in 1975 allowing engineering problems of waste processing to be solved with the help of dozens of scientific and research institutes providing this service. A general provision introduced in 1986 addressing innovation and new products development made the organization responsible for it to develop in parallel technology for their reuse or recycling. It allowed recycling waste at an industrial scale targeting by 2010 the recycling rate of most types of solid waste close to 100%. In 1990s this network of support institutions and use of policy instruments were abolished. Further policy of the Russian Federation was treating waste as a source of pollution and contamination (Zaytsev, 2018). Moreover economic and social situation in the country after the collapse of the USSR was not capable of including environmental issues in the priority list.

The system established in the USSR worked quite efficiently. For example, the city of Leningrad alone had 113 collection points. The collection rate of paper in the 1970s was 59% on average in the country and up to 80% in Moscow (Zakharov et al., 1980). Technologies for the recycling of paper as well as other materials were developed and applied for different categories of waste, including textiles, polymers, wood, tires, glass, oil products, mercury lamps, and metallurgic slag. The collapse of the political system destroyed industrial system linkages as some of its actors even found themselves in other newly created states.

New economic challenges and the need to reestablish destroyed systems diverted the attention of the Russian government from waste issues. In 1990s the issue of waste treatment was regulated at the regional level. Different types of wastes were not collected and treated properly regardless of the fact that some of those resources like construction materials or glass manufacturing were directly used for production by specific industries. Even the disposal of waste was not properly organized – the number of dumps was growing at that time as there was little control from the municipal government due to corruption and the “waste business” started to be managed by criminal groups.

Licensing transportation and waste disposal was introduced by the Government as an attempt to make order in the waste sector. Still, deficiencies in monitoring and control of use of licenses and landfills created monopoly of landfill owners on such operations and uncontrolled dumping of waste.

The issue of waste management deficiencies was emerging due to increasing social, environmental and economic pressures requiring the attention of the central government. Creating a system of waste management reached its highest point on the political agenda after the President personally addressed this issue in response to questions raised at the “direct line” – a yearly annual special communication session of citizens of Russia with Vladimir Putin, which was broadcasted on 7 June 2018 by the central TV and radio channels of the country (Kremlin, 2018).

4.2. Context of MSW reform development in Russia: a Snapshot

Waste is a standard output of both social and economic activities of population and its management should be regulated by the government as it has instruments and responsibilities related to both producers of waste (manufacturers and service providers and, ultimately, people) and its consumers (again, manufacturers, service providers). Unfortunately, an unstable political situation puts economic concerns as drivers of decisions on waste management at the state level, while social and environmental aspects are becoming only a second and third priority. It is demonstrated by the way Russian waste management legislation and practices were developing after the collapse of the USSR. It would be unfair to say that only in 2018 at that “historical” direct line with the President everything has changed in the country overnight. Thus, we have to analyze what was the state of regulation and practices in the waste sector in the country by that time, when the state WR, which was under preparation since 2014, was finally launched at the highest political level.

First, a snapshot of the state of waste generation and treatment practices in the country will be taken. Second, analysis of the waste shaping regulatory system at the national and municipal levels and, finally, discussion of management and organizational approaches driving the waste sector will be provided. All three parts will be analyzed through the prism of the ultimate goal of waste management – safety for humans and the environment, as well as resource use minimization with the guidance of the waste management hierarchy concept. Economic, political, technological and social factors enabling conditions for CE principles application will also be reviewed.

State of the waste sector in Russia before WR

According to the Report of the Ministry of Natural Resources and Ecology (MNR, 2018), 6.22 billion tons of waste were generated in Russia in 2017, including industrial waste, agricultural waste and solid waste. It is 14% more than the same number in 2016. At the same time, there is a stable relationship between economic development and waste generation: during the economic crisis in Russia in 2008, the total volume of waste generated decreased and its growth correlated with the economy recovery in 2009 when 3.5 billion tons were generated, growing to 3.7 billion tons in 2010.

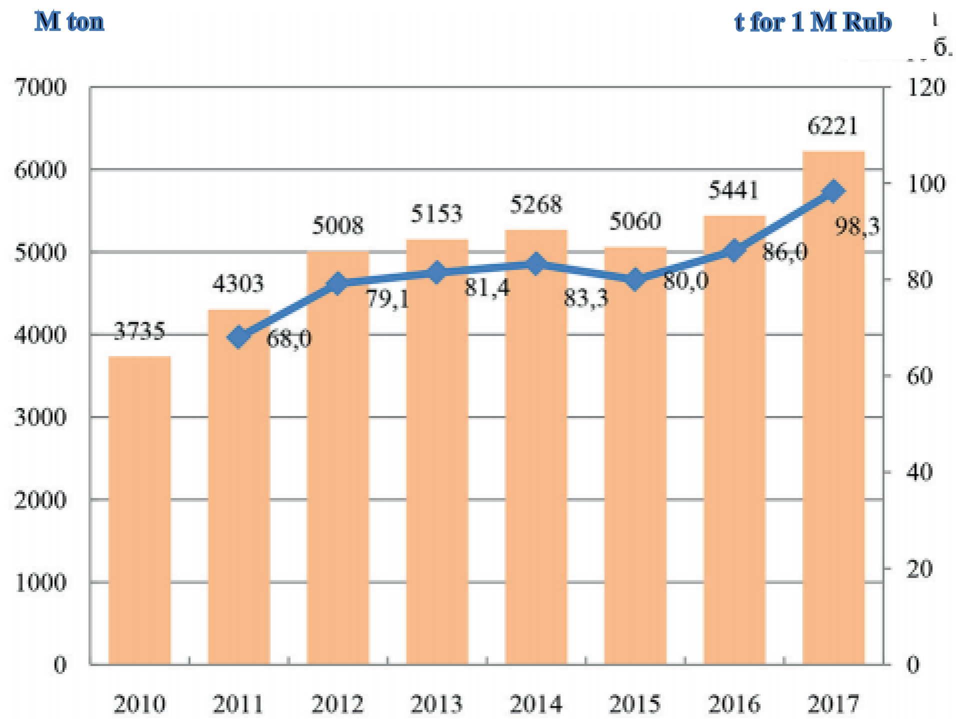

Figure 5. Dynamics of waste volumes from consumption and production in Russia with GDP unit distribution (in prices of 2011), 2010-2017 (MNR, 2018).

Most of this waste (93%) is related to waste from mining activities. Municipal Solid Waste comprises only 0.88% of the total waste (274.4 million m3 or 54.9 million tons[5] of MSW). Per capita waste generation is another useful parameter, as it links population (the main producer of waste as a driver of economic activities) to the MSW volumes, and represents 379 kg annually (population of Russia in 2017 was 144.5 million people). Which is only 100 kg less than average EU-28 per capita MSW generation (Eurostat, 2017) in 2017 ranging from 272 kg in Romania to 781 kg in Denmark, which also strongly correlates with GDP values of the countries. As the focus of this research is MSW, I will further concentrate on its generation and treatment in Russia.

In 2017 only 10% of the total generated MSW was recycled. Whereas during 2010-2017 overall volume of generated waste increased, the share of MSW in it decreased 1.4 times, still, the share of waste directed to recycling plants has also decreased by 13% (MNR, 2018). The reason behind small share of recycling of MSW is rooted in collection practices used in Russia –

[5] Calculated by author based on ration of 200 kg per 1 m3 of MSW provided in the MNR Report (MNR, 2018)

waste is not sorted at the source. Mixed MSW collection system "*not only reduces the amount of selected secondary resources but also increases the load on landfills*" which received 87% of all MSW in 2017 (ibid).

Annually, most MSW is generated in megalopolises like Moscow (4.8 Mt[6]), St. Petersburg (2.1 Mt), Samara (1.4 Mt) and Novosibirsk (1 Mt), representing 17% of total MSW generation in the country in 2017. In general, the cost of 1 ton of MSW treatment including transportation, sorting and further landfilling in 2017 was approximately 500 rubles per 1m3 (34.5 EUR per 1 ton) in Moscow and the Moscow region. Still Moscow on its own generates about 9% of MSW of the whole country, demonstrating the effect of urbanization, satisfying the proximity principle[7] of waste management. Waste recycling facilities benefit from securing the supply of valuable waste fractions in a bigger city, which is not the case for smaller settlements (transportation to and from which in far north and other remote parts of Russia could even be seasonal).

The MSW composition determines its management, as it guides the requirements for the collection and disposal system according to the concept of waste hierarchy and it is becoming even more important when choosing treatment options. The composition of MSW in Russian cities is provided below (Table 1). The average morphological composition of MSW correlates with the level of economic development as well as parameters of climate, season and geographical location of Russia and could be compared with MSW composition of cities located in similar climate zones of the EU. Most common recyclables content presented in the table below shows that organic fraction of MSW (including paper, cardboard and food waste) reaches up to 80% of the total MSW volume, which in turn confirms the choice of recycling as an option to minimize landfilling.

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[6] Million tons.

[7] Waste should be treated and recycled close to its source.

Table 1. Averaged content of recyclables in MSW of selected cities of Russia

Components	Content, mass in %
Paper and cardboard	33-40
Food waste	27-33
Metals	2.9-4.2
Textiles	4.6-6.5
Glass	2.7-4.3
Stones, ceramics	0.7-1.0
Polymers	4.6-6.0

Source: MNR Report, 2016

Whereas composition of MSW and its generation per capita are comparable with average EU member countries, waste recovery in Russia is not the same (see Figure 6).

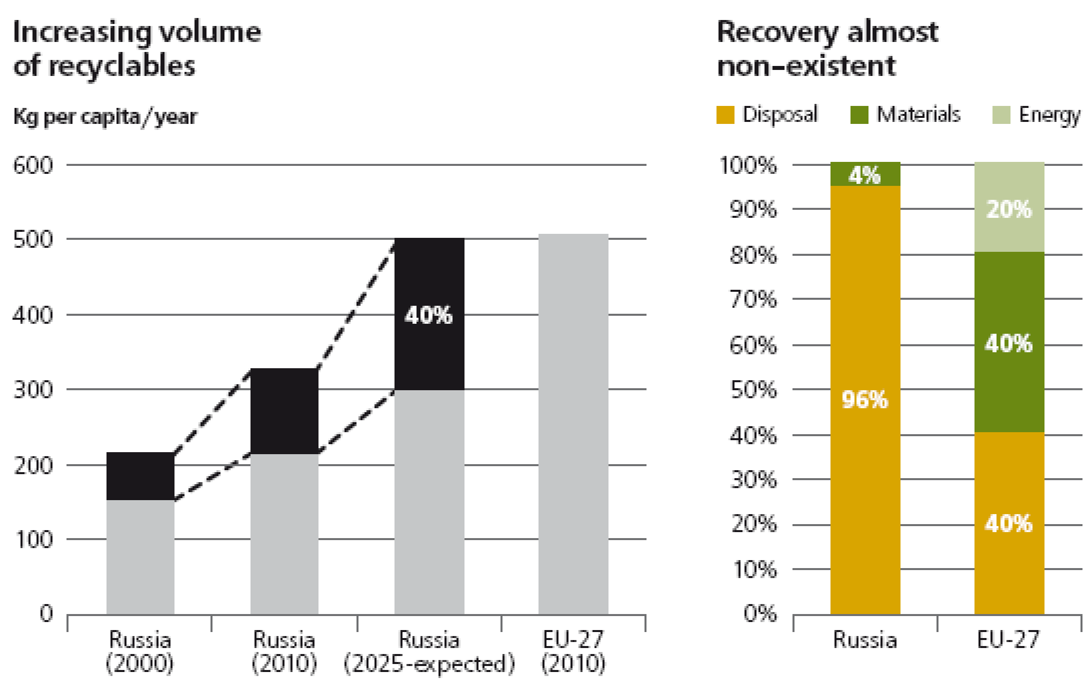

Figure 6. Comparable MSW generation and recovery8 rates (IFC, 2012).

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8 Here, (left) share of recyclable part will reach 40% by 2025; (right) recovery does not include incinerated waste.

Definitions of waste in Russian legislation corresponds to the definitions developed internationally. Still, an important part of waste treatment regulation is related to categories of waste, where hazardous wastes might also be generated as a part of MSW and, thus, treatment of such waste requires special conditions even for landfilling.

According to the MNR, 32 billion tons of waste were accumulated in solid waste landfills by 2011, including industrial, agricultural and household waste. Most of this waste was and still is dumped without specific treatment, thus issues of GHG emissions, fires and other hazards are associated with such waste treatment practice. According to Rosprirodnadzor[9] RF, there are 1,092 engineered landfills for MSW in Russia as well as 15,000 legalized dumps, 243 MSW treatment facilities and 10 incineration plants (which use 4% of MSW) (Accounting Chamber, 2016). The overall surface occupied only by legal landfills is over 40,000 km2 (ibid.) – about 0.003% of the whole territory. 400 km2 is annually provided for MSW disposal.

In line with identified key numbers and characteristics of waste generation and treatment practices in Russia, one could conclude that with the tendency of MSW volumes to increase, higher volumes of its recyclable fractions (IFC, 2012) become available. Thus, the model of MSW treatment with the majority of waste landfilled is not sustainable as it negatively impacts the environment and creates losses of valuable materials. Recognizing those trends led to changes in policies and regulations of MSW launched in Russia in 2014 reaching its apotheosis in 2019 as a WR implementation of the Government. I will review the key aspects of this reform in chapter 4 and the final part of the current thesis to analyze whether unsustainable practices of thee recent past are changing through introduced reform and how far they correspond to CE requirements of the global agenda. In the next section, I will describe some regulatory, legislative and governance parameters of waste management in Russia which also contributed to the major reform as drivers of the necessary change.

Legal and regulatory frameworks of MSW management

State waste policy is regulated based on four key Federal Laws, including “Law on environment protection” issued in 1991 and its amendments from 2002; “Law on sanitary-epidemiological wellbeing of the population” from 1991 with amendments from 1999; “Law of ecological expertise” from July 1995 with amendment from 2015 as well as “Law on waste of

[9] Federal Service for Supervision of Natural Resources

production and consumption" (FZ89) from 1998. Those laws are addressing minimization of waste creation; maximum use of waste for economic activities and, ultimately, recovery of materials and energy. Waste treatment and recycling in line with environmental protection and economic efficiency are seen as enablers of better sanitary conditions in the settlements as well as transition from landfilling to industrial waste processing - recycling. The latter emerged as a priority only recently as there was no unified approach to it. The overall management of waste was organized by separate economic agents in line with existing legislation. A comparative scheme of WM guiding documents in Russia and the EU is presented below.

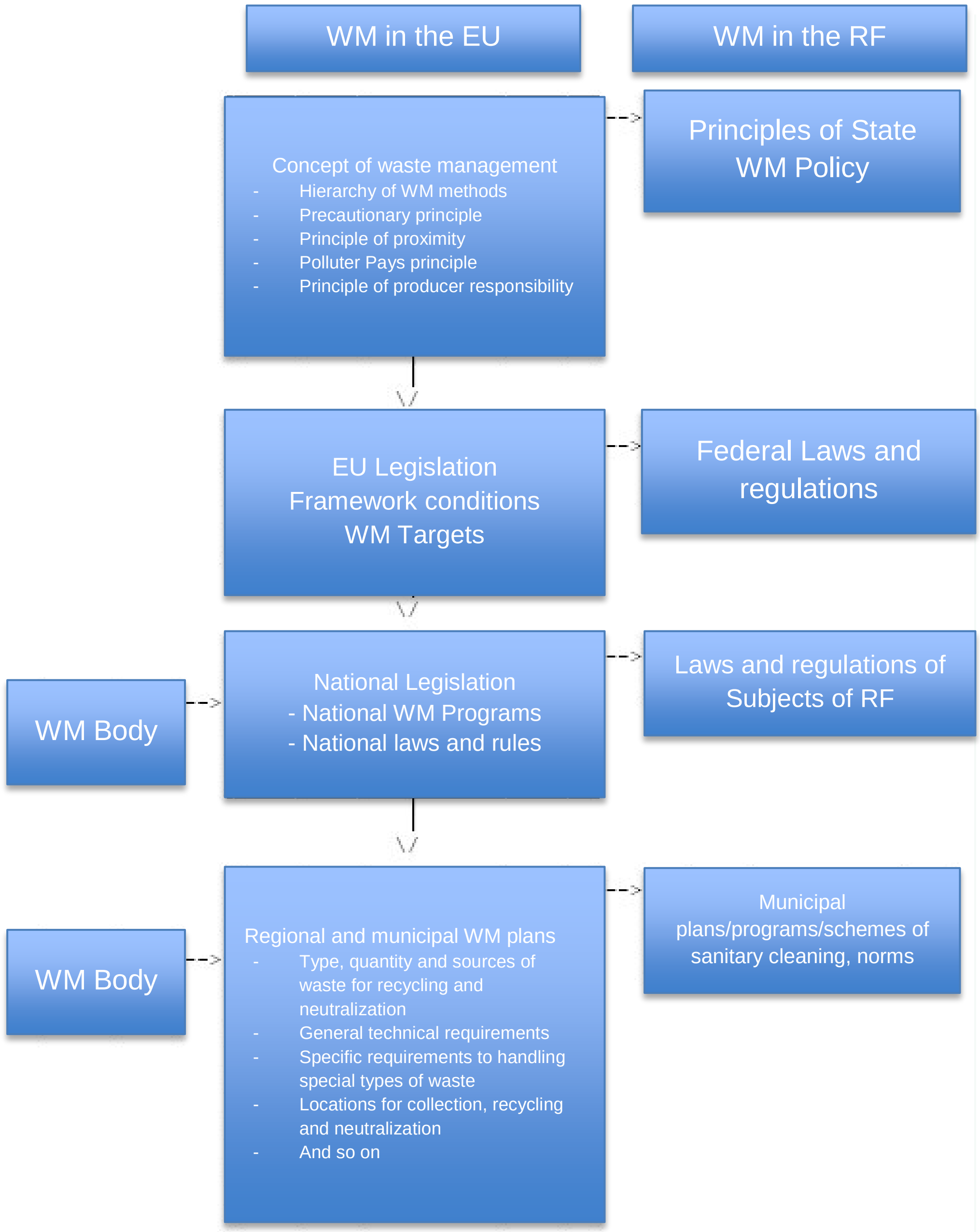

Figure 7. Comparative Scheme of waste management guiding documents in the EU and Russia (MENR NN, 2019)

The Federal Law “On Production and Consumption Wastes” adopted in 1998 when there have been significant changes both in the development of international legislation and in approaches to waste management with emerging strategies focusing on secondary raw materials. Being guided by the international environmental law, national legislation reflected the waste hierarchy approach putting waste prevention and recycling as a priority over disposal. Still, costs of recycling and composting (including its sorting to ensure quality of final product) were at least 1.5 higher than costs of landfilling - a traditional practice in Russia. The Federal Law "On Technical Regulation" (FZ184 from 2002) has changed the system of normative regulation in the environmental sphere emphasizing the need to address negative impact of production and consumption waste. It contributed to the formation of technical legislation with higher environmental standards. The whole system of related laws was changing to introduce new technical requirements into production and consumption waste management as of 2014 guided by the Law on Waste (FZ-458 - an updated FZ89) - known as the “Waste Law”, adoption of which triggered amendments in the key waste legislation in 2017.

Box 8. Key results of new Waste Law adoption in 2014

Adoption in 2014 of the amended[1] Waste Law significantly changed legislation on waste management which became one of the first steps to establish waste processing industry in Russia. It provided more comprehensive definitions of the key terminology in waste area, including new terms like recycling or recuperation. MSW was specifically defined in relation to its generation in residential areas and included compatible waste from activities of enterprises and organizations.

Other changes included definitions of WM processes, including sorting, collection, accumulation, disassembling, recycling and treatment for further processing as well as disposal. This clarification was useful for further development of waste treatment and processing activities requiring deeper processing and decontamination (neutralsation). The latter defined as a process of mass and composition change reflected in the change of chemical and physical characteristics of waste is still misleading the data collection as neutralization is seen as processing and even recycling of waste. Categories of waste were clarified with special requirement to license treatment of hazardous waste.

Big step introduced by the new Waste Law was responsibility of producers “for utilization of products, which became waste”. Here, differentiation between MSW and waste from use of products was underlined. Specific ways to address this responsibility were also defined, including construction of own waste processing infrastructure or payment of an environmental fee to exercise the globally known practice of Extended Producer Responsibility (EPR).

Waste Law amendment was a result of the Federal Target Program “Waste”, which was adopted by the Government in 1996 to “*create normative and technological basis for realization of a common waste management state policy on all levels of governance, stabilization and, further, decrease and liquidation of environment pollution by waste, economy of natural resources due to maximum involvement of waste into economic activities*” (Government Decree, 1996). Apart from those goals, the program was addressing reduction of waste generation on the basis of low-waste or zero-waste technologies; reduction of types and quantities of toxic and hazardous wastes based on new technological solutions; effective use of raw materials and energy potential of secondary resources; ecologically safe disposal of waste; and targeted distribution of financial and other means to liquidation of waste and its involvement into economic activities. Creating common information database on waste with regional databases was a necessary condition of the program, 80% which was funded by the state budget with an expectation to cover the remaining 20% of it through revenues from processing and sale of secondary raw materials (IFC, 2013). Lack of financing became one of the reasons why the program goals were not reached, although it became a basis for the Waste Law adoption as well as development of strategies of waste management in almost all regions of the country.

Another related initiative was the State Program of the Russian Federation "Environment protection" 2012-2020 which analyzed ecologic situation in Russia partially recognizing environment damages of increase in consumption and production and related waste. This Program also identified issues of MSW disposal to dumps and landfills which are not corresponding to the requirements of ecological security (Government Decree, 2017). It was concluded that "*current situation in Russia on...waste leads to dangerous pollution of environment, irrational use of natural resources, significant economic damage and presents a real threat to health of nowadays and future generations…*". As a result, measures to improve the system of state regulation of waste as well as development of waste processing infrastructure capacities, information support to state database of waste as well as implementation of best available technologies (BATs) were proposed.

Box 9. BATs as a normative tool for MSW management in Russia

Requirements and regulations on waste treatment and disposal are not the only way to stimulate the actors in waste sector to engage into environmentally friendly operations. Technical guidelines and norms are also developed and used in Russia. After the entry into force of the Federal Law "On Technical Regulation" (No. 184-FZ, 2002), the system of normative regulation of environmental and waste specifically has changed. Notion of BATs, which was already present in different shape in the technical field, was reformed together with update of regulation on technical norms in general and the norms of negative environment impact in particular. *BATs were defined as the best available manufacturing technology for production (goods), provision of services and works on the bases of modern achievements of science and technology as well as the best combination of criteria of reaching the goals of environment protection under the condition of technical capacity of its application.*

A list of 51 BATs was developed in 2015-2017 (using European model adopted to Russian conditions) and accompanied by 51 guidelines (Information and Technical Guidelines, ITGs - analog of EU's BREFs) on their application in selected industrial sectors. Companies were encouraged to apply BATs as guides to more efficient resource saving technologies, which would allow reduction of payment for negative impact on environment and a basis for State support. Construction of new enterprises from 2019 will be possible only based on BATs, whereas already existing enterprises will have to apply for Integrated Environmental Permits (IEPs) only as of 2020. Enterprises of the Ist category (a so called "list of 300"), which have the maximum negative impact on environment in total accounting for 60% of emissions in Russia (Guseva, 2018) are the focus of obligatory BATs application, although others could apply them on voluntary basis or to develop programs to increase ecological efficiency as an alternative. Data from BATs should also be used for programs and projects of industrial modernization and manufacturing.

Waste-specific BAT guide ITG 17-2016 was also developed by the Bureau of BATs[10] listing recommendations on technologies of production and consumption waste disposal. There are other normative acts supporting waste norms application provided by the system of the Russian Standards Organization (GOST, 2014) as well as international standards (ISO).

The laws and regulations related to environment protection and waste management, include Art.72 of the Constitution (where environment protection and use of resources are jointly governed) as well as sectoral laws (on atomic energy, water use, pesticides and agrochemicals regulations), Government and President Decrees etc., but those are only adding to the key waste management legislation described above.

Information Tools

Whereas regulation of waste related issues in the country was becoming clearer with adoption of new legislation, still, decision making was lacking comprehensive data on waste, its content, including secondary materials, which was not uniformly collected or stored in the country. Some of this information contained in the statistical reporting (in so called Form No. 14-CH) and environmental passports of enterprises reflecting "Waste disposal limits" (Form 2TP-toxic waste). *Every enterprise* had to develop draft norms for the generation of waste and its

[10] State agency created as an assignee of famous Gosplan system institute - All Union Design and Technology Institute of Secondary Resources, based on Science and Research Institute "Center of Ecological Industrial Policy"of the Ministry of Industry and Trade. (www.burondt.ru)

limits for disposal (Yakovlev, 1999) and in some industries and regions automated data banks for certain types of waste have been developed. However, in practice clarity on waste generation, content, distribution options was not in place thus, statics for decision making on waste management remained scattered and mostly unreliable although national level database of types of wastes and related facilities was developed as a Federal Waste Cadastre (FWC, 2014) (Box 10).

Box 10. Content of the Federal Waste Cadastre (FKKO)

(1) a Catalog with composition data and properties of production and consumption wastes (so called FKKO) developed in 2014 and further amended several times to the current version from February 2018.

(2) a Register - the state register of waste disposal facilities, which contains data on temporary and permanent disposal facilities for production and consumption waste (so called GRORO).

(3) a Database of waste use and disposal technologies (DWDT) - a set of systematized information on the technologies of processing, use and disposal of specific types of waste generation and "consumption".

MSW Governance and Key Players

Sources of waste production/generation (individuals, entrepreneurs, small and big manufacturing enterprises, organizations etc.) are all associated with economic agents of a state, and waste consumption (processing, treatment, disposal etc.) could be of interest to any of those for different reasons. WMPs are developed to regulate those interests according to an agreed plan prepared in consultation with interested stakeholders and approved by responsible authorities based on quality and quantity of available waste, local experience as well as waste processing capacities in the region and BATs. Here the role of the government is to set priorities in line with the key in the international practice: waste reduction, continuous use of materials and energy contained in waste while respecting environmental requirements.

WM is an important component of state governance in Russia at different levels from the central (federal) to levels of regions (Subjects of RF) and municipalities (see the structure of governance in Russia in the Annex 2). Waste Law initially assigned waste management as a responsibility of municipal authorities. State control include control of compliance with environmental, technological, sanitary and other waste handling requirements; compliance with the requirements for transboundary movement of waste; control of the accuracy of the information provided in the field of waste management; identification of violations of the legislation of the Russian Federation in this area and bringing those responsible to justice, etc.

After the collapse of Soviet Union, the role of the state in organizing the collection and recycling of waste has dramatically decreased for a decade and started to gain its new shape only by 2010. Still, it was not clear as roles and responsibilities were distributed among different bodies involved in waste management, including federal and regional authorities which were in the process of constant reform. Whereas control and inspectorate bodies were performing their tasks, governance system of waste management actors was not in place, although elements of a system were functioning to fulfill existing waste regulations driven by market needs. Structure of such a market with actors of waste treatment and recycling is presented below (Figure 8).

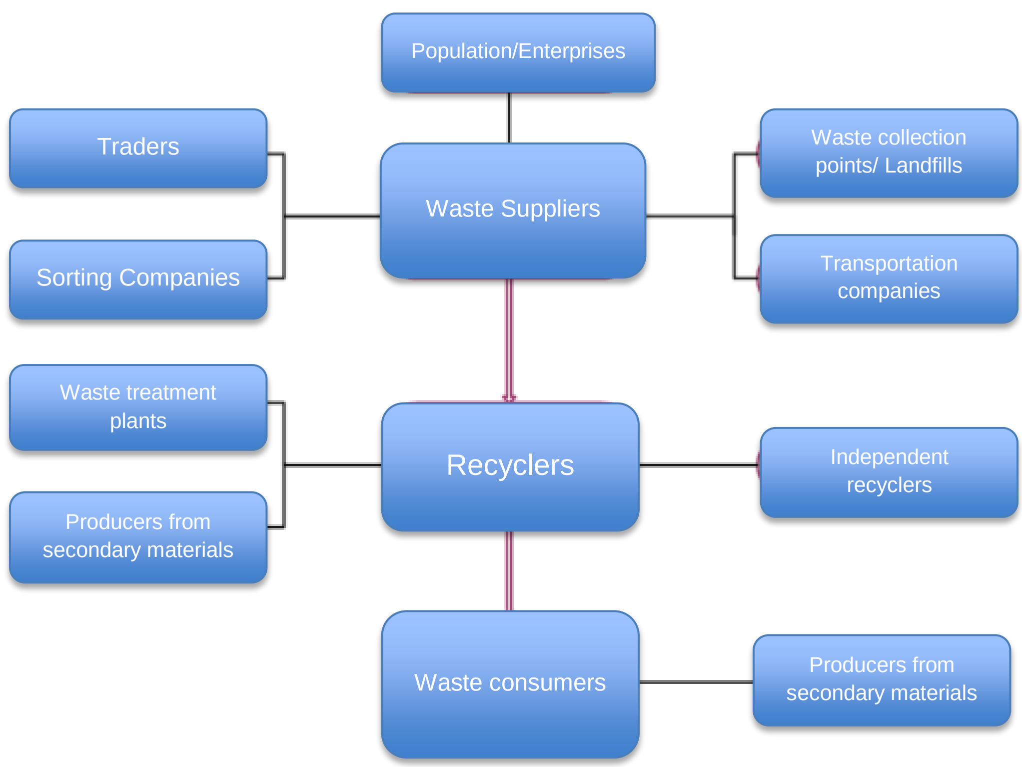

Figure 8. Market structure of MSW treatment (Cleandex, 2010).

Already by 2010 statistics indicated "*11 000 landfills and dumps; 4 incineration plants (in Moscow); 5 waste treatment plants; 39 waste sorting factories and over 1000 MSW transportation companies*" although overall WM system conditions were not competitive and had location-specific actors (each region had only one group of MSW market players and roles were divided) (Ibid).

Market assumes actors and subject of interest – waste, property rights on its valuable content belong to entrepreneurs and organizations which generate those wastes. Specific actors of the system with rights and responsibilities associated with their roles are presented below (Table 2).

Table 2. Distribution of Responsibilities among Players of Waste Treatment Sector

Function	**Player**
Rights: waste ownership rights Responsibilities: ensuring environment protection	Population, organizations, entrepreneurs
Rights: benefiting from capital management, transfer of property rights Responsibilities: compensate factual impact on environment	Organizations, entrepreneurs
Organize collection and transportation of waste from settlements	Local (municipal) authorities
Organizing waste disposal	Federal subject
Proper use of infrastructure and provision of collection, transportation and disposal services against the fee	Contracted specialized organizations
Licensing and monitoring of proper services, evaluation of technical, sanitary and ecological security of objects - existing and under construction	Regional representatives of federal agencies protecting: technical (Rostehnadzor), nature protection (Rosprirodnadzor) and consumer (Rospotrebnadzor) rights.

Source: IFC, 2013

Such distribution of rights and responsibilities prevents businesses from actively participating in the waste market, affecting competition and, thus, limiting quality of services received by population and other “waste producers”. The situation of multiple actors sharing responsibilities and exercising rights in different parts of waste management cycle could also be seen through a loop of a value chain as from being zero or even negative the price of waste is growing in the process of its (a) decomposition by component (sorting) and (b) increase of its volume (collection and transportation to the sorting and/or treatment facility). Thus, it was recognized that “*existing waste management system is not capable of providing quality and effectiveness of services*” (Ibid). For that reason further development of legislation and regulation in WM area by the adoption of the new Waste Law was welcomed by the waste market players.

Management in the waste sector is guided by a number of programming documents adopted by the Russian government in parallel to the adoption of the Waste Law and regulations.

Those documents include a Complex strategy of solid waste management in the Russian Federation (2013), Strategy of ecological security (2017) and others.

Economic stimulus and incentives for waste management

Problems of legislation are not the only ones in the field of waste management. Many issues are routed in financial and economic regulation. Administrative methods seem to outline the scope of economic mechanisms, since the introduction of environmental payments is possible only with a strictly regulated system of state standards which still exist. *Environmental tax* in the form of the *fee for negative impact on environment* is the most relevant payment from legal bodies and entrepreneurs which could be mentioned in the context of waste management. Other fees include *tariffs for communal services* as well as penalties and fines for non-compliance.

According to the Law of the Russian Federation "On the Tax on the Profit of Enterprises and Organizations" and the instructions[11] of the State Tax Service, the tax rate of the capital investments was reduced by 30% if environmental protection measures including waste management related are introduced by the company.

Another stimulating factor for landfilled waste minimization is recycling. Taking into consideration that seventy million people (more than 50%) in the Russian Federation live in large settlements and suburbs which accumulates annually about thirty million tons of MSW, one could calculate that valuable fractions of this waste could be extracted and monetized through the technologies of integrated resource conservation. It is also beneficial for the MSW impact on the environment as after extracting valuable resources from the total mass of waste for disposal, no more than a quarter of the neutralized, inert waste will remain for incineration or landfilling. Unfortunately waste recycling and processing was not connected to the financing WMS establishment in the country. It became necessary to overcome cultural perception of waste as an unavoidable evil which could still bring value to the society and to promote recycling as a way to save resources and even products for some industries.

[11] Instructions "On the Procedure for Calculating and Paying the Tax on the Profit of Enterprises and Organizations to the Budget"

4.3. Building MSW Management Framework: Waste Reform in Action

Whereas the first attempt to reform WM sector could be traced back to the 90s, its real implementation was initiated in 2014 and fully launched on 1.01.2019. Legislative and regulatory framework of utilities sector was gradually adjusted to create new approaches to WM. Provisions were made to regulate activities of MSWM actors with careful considerations on financing those changes without harming people's wellbeing. It is important to create waste management industry and the focus of Russian Government in this process is to attract private investors support.

The MSW Reform had the *targets* which are grouped by factors helping to shift MSW system to enable circularity practices discussed in the chapter 3.5.:

1) *Organizational (administrative)*: incorporate fractions and components collection phase of WM process; build integrated waste management system(s) at national and regional levels;
2) *Political and regulatory (governance)*: move the responsibility from municipal to regional (Subjects of RF) level; reduce MSW generation and landfilling;
3) *Technological*: increase the role of recycling in MSW handling;

Whereas those groups are interconnected, they also require *economic and financial*, *educational and knowledge* factors to be in place. Complexity of planned activities delayed the launch of the reform for two years[12]. Long launch made the reform expected by the actors of MSW system, but still, actual implementation uncovered several barriers, specifically: *economic* (RO tariff did not fully cover waste collection and management, hampering recycling industry development) and *organizational* (requirements and regulations as well as property rights, subordination and responsibilities at each stage of waste management process). The *elements* introduced to support the reform included territorial schemes with regional programs of implementation and regional operators responsible for their implementation funded by regulatory tariffs.

Organizational Factors: Territorial Schemes

Overall waste management planning in Russia using the key priorities is now realized through "territorial schemes" (TSs). Those schemes were adopted by the Government Decree

[12] Was planned to be in 2017 - the Year of Ecology 2017 in Russia.

(Government Decree, 2016) to guide waste management. TSs are considered as local WMSs as they describe the key players, their roles and interlinkages. In detail, a TS contains graphical (plans, figures etc.) and text description of system of organization and governance of waste (including MSW) collection, transportation, treatment, utilization, disposal and landfilling. Those schemes are comprised of flow schemes by waste types (i.e. flow of plastics) and their "movement" from production to consumption graphically reflecting direction of the flow and quantity of waste (see the example on Figure 9).

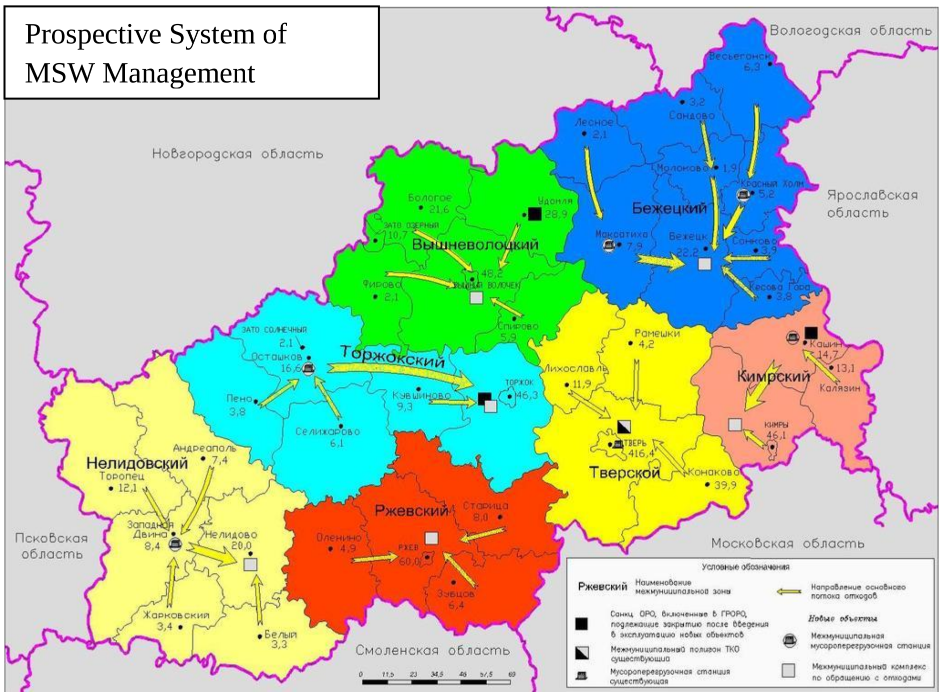

Figure 9. Example TS of Tver region: MSW flows from generation to treatment facilities (TS Project in Tver Region, 2015).

Regional Operators (ROs) concentrate management of waste value chain from its generation to "consumption" as proposed by Waste Law in 2014 - the reason why some experts called this law "revolutionary" and the core of Waste Reform.
The ROs are accumulating both administrative and regulatory functions necessary to improve MSW market, including scale and continuation of industrial process, guaranties of waste flows and clarity in selection of its players.

Those territorial schemes are approved by the state authority[13]. At the same time, a concrete body (a so-called Regional Operator, RO) is assigned to collect, transport, treat, utilize, dispose and landfill MSW in line with a regional Program of waste disposal attached to the TS.

[13] At the regional level except for large cities like St. Petersburg and Moscow according to the Art. 23 of the Waste Law.

Thus, Waste Reform "was born" in 2014 and became a reality as of 1 January 2019 when institute of ROs was launched. Operationalization of ROs as a sign of full speed implementation of the WR in conjunction with crystallization of waste management system with its rules, actors, linkages and markets is a step towards creating a new *waste processing and recycling industry*.

Governance Factors

Establishing ROs was suggested as a coordinating agent model (IFC Report, 2012) in Russia to centralize WM of each region to operate contracts with service providers and infrastructure operators. RO is responsible for management of waste streams, although the tariff policy for population and the overall framework for operation are established by municipalities contracting ROs. ROs work plans are based on programs prepared with TSs establishing the rules of the game for the ROs. Those work plans require review based on already accumulated experience.

WR also targeted improvement and compilation of the regional TSs at the national level to avoid duplication of roles and responsibilities at the federal, regional and municipal levels. Overall political and conceptual guidance of the MSW management, being a sensitive social issue, required special attention. Recognizing the importance of resource efficiency as an indicator of economic development and the need to organize WMS integrated with circular production practices, the MNR established a state company. The single integrator (National Ecological Operator, NEO) was established in 2018 within the framework of the national project "Ecology" – a project targeting 60% of MSW recycling rate by 2024 with the processing capacity to be put into commercial operation for 21.7 million tons of MSW by 2022 and even 37.1 million tons by 2024 (RBC, 2018).

> NEO will develop a unified scheme for the distribution of waste, which will consolidate data on capacities, storage, locations, transportation routes and plans to establish new facilities (for treatment, disposal and storage of waste) as its operator. The state-owned company will also coordinate territorial waste management schemes, develop incentives for and implement state programs and proposals to increase awareness about government policies and plans in the field of waste management. Its budget will be formed by the environmental fee collected by the government.

Financing of the integrated system of handling MSW for the period till 2024 requires 291 billion rubles[14] in total, from which state budget comprises 36%. The required budget is expected to be acquired through investment MSW

[14] According to Waste Strategy 2030, creating modern waste recycling industry in Russia will require investment of 5 trillion rubles (approximately 680 billion Euro).

projects with active participation of the private sector exploring PPP and other modalities. It is also planned to issue "green" bonds, loans and credits to support the project. Annual revenues from the federal budget will consist of an environmental fee, funds from the national project "Ecology" and targeted subsidies from the Government.

Economy of WR

The following tariffs were introduced to support funding of the new system: unified tariff for services of RO on MSW handling[15]; tariff for MSW treatment; tariff on MSW disposal; tariff on landfilling of MSW. Selection of RO on the tender basis has price of service at first place; together with other requirements[16]. Tariff regulation is not clear for the consumer (as it is not related to the factual volume and content of waste) and it is not sufficient for the RO operation itself. Initially a single tariff of the regional operator was established in line with the range of services, but it does not take into account costs of processing (and sorting) of MSW.

Other financial issues are related to the fee for negative impact on the environment (NIEF) as it represents source of financial inflows from the population for communal services operators (including waste management). Volume of this payment in the state budget was 27 billion rubles in 2017 (Zhukov, 2017). Environmental fee (EF) is another big issue for the ERP (see the Box 11 below): if producers prefer to pay the EF as there is no interconnection between its collection and targeted recycling.

[15] Could be differentiated by type of MSW - sorted, mixed, large etc. and class of danger I-V; by municipality type; by technological specification of the TS.

[16] Quality of service: reliability, operation speed for citizens' requests; openness (web page and exchange of information with customers by email); diligence.

Box 11. EPR regulation in Russia

Since 2015, companies should apply the extended producer responsibility (EPR) mechanism, which assumes that the manufacturer and importer of goods are responsible for the disposal of released or imported products at the end of its life cycle. In the article 24.2 of the Waste Law three options are available:

- independent implementation of goods recycling standards by importers and producers;
- subcontracting recycling to waste processing enterprises;
- payment of environmental fee.

Enterprises can themselves create direct schemes (product - consumption - waste - recycling - product) through operating or subcontracting recycling facilities, reducing packaging and other materials content of their products, i.e. being directly engaged. Still there is a lack of a systematic approach to stimulating the development of the entire system and increasing the investment attractiveness of the recycling industry, since the environmental tax rates are several times lower than the costs incurred by companies when building their own systems for collecting and recycling waste.

It is still necessary to clarify what is added value of EPR for the manufacturer as the usual responsibility of the manufacturer is to control and ensure the product life cycle from design to consumption. Extending it to the waste management process should cause changes at all stages of the life cycle in order to minimize waste volumes at the last stage. This, in turn, connects use of materials keeping the design out waste principle of CE in focus. However, the task of EPR in Russia today is seen as reduced to the financing of the waste treatment industry as the state forces enterprises to participate in a state investment project without providing any guarantees for the investments return at a system level.

Other measures of economic stimulation include compensation of interest rate of credits related to waste utilization and reduction of revenue tax and offsetting/crediting NIEF payment as a partial compensation for investment into such technologies. In general, NIEF payment should be higher than costs of implementing waste recycling technologies period of project planning, i.e. it should be a prohibitive level of payment to stimulate recycling industry. Still, it is at least a step into the right direction as there is no other mechanism for it like preferential green credits, targeted project financing or regional environmental funds (which are also supposed to be supported by the government by up to 70%). NIEF payment should also be targeting only waste management and utilization/impact offsetting measures in contrast to today’s practice.

4.4. Key Gaps of the MSW Reform

Policy, Regulation and Governance

Reform became a big step forward for WM in Russia as it prioritizes waste recycling, formulates a related development strategy and supportive legislation with key instruments like WM TSs; ROs responsible for the whole cycle of waste management and necessary infrastructure; and identified financial means for those changes - a regional tariff for WM service. Still, the issue of regional operators tariff became obvious in practice as, being calculated at approximately 500 Roubles per capita monthly (about 6.8 EUR), it has no investment component as well as planned expenditures on sorting and utilization (recycling) of waste.

At the same time Waste Strategy 2030 established waste processing industry proposing construction of modern high-tech recycling facilities, and included waste minimization for non-recyclable waste as the main goal of WR. According to the Strategy, volume of waste will decrease by 8.8% till 2030 and the volume of whole (not only MSW) utilized and neutralized waste in the country will increase from 59.6 to 86% (Volkova A.V., 2018). This should increase the GDP by 0.03% from 0.08 to 0.11%. Construction of recycling facilities would also require financing and relying on public-private partnerships in this regard is possible only with clear rules of the game for the private sector: definition of waste ownership; clear separation of waste and product notions (waste as a product/resource is an issue for existing classifications); secondary materials market stimulation and support among others - which is still not the case.

In order to make the waste sector effective, it is planned to adjust regulatory base, create complex system of management and regulation, complex TSs for development and location of industrial facilities, necessary technological and production means to promote recycling as the key strategy for waste minimization. The next period of Reform planned for 2022-2030 assumes scaling up waste industry in the regions and developing scientific and technological industrial infrastructure to produce *recycling equipment* as a part of import substitution policy of the Government.

Making waste management system contributing to circularity principles requires priority of recycling over incineration and landfilling to be supported by new regulatory mechanisms like ban on landfilling of waste containing valuable components and promotion of EPR.

Shift of MSW management to Circularity

A TS-based RO tariff stimulates accumulation of all financial flows from the MSW generators in one place. Selected on the tender basis for up to 10 years of operation RO contracts out actual operation of WM or does it on its own. This clarifies interrelations among all participants of MSW sector interested in recycling supporting mechanism. Having RO as a coordinating body also allows to track raw materials flows as it has to create infrastructure to collect and transport waste and to establish the necessary sorting facilities. As in 2019 already 85 Subjects of RF had their TSs and even Programs of implementation in 52 of those regions, having ROs selected in 23 region contributed to accumulation of experience for ROs to identify barriers preventing implementation of recycling ambition (MNR, 2017).

However, while roadmaps of transition to new system of waste management were approved in 74 regions the TSs system is not unified and plans for construction of new facilities are not comparable having some programs even relying on “increase of waste flows”, which contradicts to the goals of the state policy to minimize waste. Still, overcoming those gaps through a single window of a National Ecological Operator, which should have an overview of situation in the regions and the ambition to introduce circularity to preserve resources, should help the regions in achieving their recycling goals.

Financing MSW Recycling

As an excellent tool of moving to better preservation of materials value in the economic system, *EPR* allows producers and importers of goods to organize their contribution to better circularity of materials and products addressing waste issue already at the production or even design stage. The latter is linking WMS with production system, where choice of technology and material influences the length of life cycle stimulating waste minimization.

Unfortunately in Russia the current norms of recycling covered by EPR are low and payment of the still low Environmental Fee instead of redesigning the product or its packaging for longer durability or less waste, easier reuse and recycling might be more attractive. Measures should be taken to engage manufacturers in a dialogue and create conditions to promote their engagement in EPR realization. It is critical for the government to demonstrate that it is interested in co-financing waste management using the collected environmental fees and adding to businesses’ efforts to establish recycling and secondary materials circulation.

Both producers and ROs could organize recycling independently or through contract-based services with a licensed recycling operators, which are the same in the region, i.e. there is no need to create competition for commonly desirable outputs.

Knowledge, Education and Information

Information and education is critical to shift WM to the new paradigm in the country. In particular, EPR could be successfully demonstrated through cases of recycling of goods and packaging organized by sectoral associations performing intermediary function for both - ROs and producers. Improving ERP regulation and using *better nomenclatures* (classification of locally produced and imported goods) for goods with complex composition of production materials facilitates demand for goods and develops secondary materials market. Well-regulated reporting from the business on higher norms of recycling helps to overcome their financial and reputational risks as well as provides incentives for other producers. Better information flows and consultations on the basis of success stories of recycling facilitates communication between government and business building better understanding on mutual goals and ways to reach circular options.

Nevertheless, ROs could use Environmental Fee collected by the government targeting sorting and recycling installations, including construction of new facilities or even incineration plants if this option of recovery is not accessible in the region. As weight of waste is taken into consideration for calculations of environmental fees, LCA could be used in non-straightforward cases to identify more environmentally friendly MSW treatment choices. Demonstrating implementation of common goals, government stimulates business to go beyond environmental fees, promoting business models in CE application in the country.

Gradual *landfilling ban* for types of waste, which contain valuable components (182 types in FKKO) is targeting return of valuable materials back into production cycle and stimulate solution of the issue of raw materials for manufacturers to reach some tangible levels already by 2024. Still, to achieve this goal collection infrastructure and sorting facilities for utilisation should be improved accompanied with educational and information campaigns for manufacturing companies and population rewarding their conscious environmental behavior.

The whole concept of *secondary resources* should be reviewed and put in another perspective with actions required along the whole value chain - from sustainable production and responsible use to conscious disposal and recycling (return into the economy). Giving those resources the same status or even higher recognition (subject to quality requirements, of course) would boost recycling sector. Information and consulting services (including state information system “Industry”) and preferential conditions for public procurement stimulate establishment of recycling culture in the country. The latter is critically important as a demonstration of the State to move to the new type of economy – supporting WR through its own green procurement practices. Using public procurement in this regard is seen as a good way for government to demonstrate its circularity-oriented mind while stimulating supply to meet demand for secondary resources and goods.

Clarification on what is waste and under which conditions it could be considered a product is still required (i.e. transition of waste into the state of product, although the name might remain, but for other industries it is becoming a product), as there is no procedure to change the status of waste to a status of a product. It is required to develop a mechanism of transition of former waste into the status of product in connection to a concrete producer, even if FKKO includes it with the same name.

Single regulating body issue was solved with creation of the *National Ecological Operator*, which absorbed functions distributed among several governmental bodies on waste management. Its focus now is to prevent deficit of waste for recycling through specific waste policy. Thus, additional measures should be taken to promote sorting among population, organizations and businesses; developing separate waste collection infrastructure and promote its use as an obligation among the users. Information plays an important role in this process, including information on principles and goals of separate collection; places of collection of different fractions and types of waste (including information platforms containing this information); making users aware about the faith of separately collected fractions (demonstration; articles in media etc.); as well as promotion of the WR through success stories and achieved results.

Financing issues

Having clear understanding that at current stage recycling could not be seen as the main financial driver to shift WM to recycling paradigm, government plans funding for Waste Strategy mostly from the state budget, although PPPs investment are expected to become the main source of financing driving recycling business model. Subsidies of waste sorting and utilisation capacities at the moment is a priority to help establishing new practices in the country.

Government also provides financial benefits for infrastructure projects to stimulate waste processing industry in general as a part of overall industrial policy[17] of Russia.

A summary on identified gaps and related solutions is provided in Box 12.

Box 12. The remaining issues and ways forward

The remaining issues for the Waste Reform grouped by factors are summarized below.

Information and knowledge:

1. Reliable information about the real scale of waste generation and content developed using modern accounting and control system both at the national and regional levels.
2. Underdevelopment of the culture of separate waste collection.
3. Secondary raw materials specification and use, including property rights.
4. Unclear status of thermal treatment (incineration).

Technological:

5. The lack of technology combining different methods of recycling for sorted and mixed waste.
6. Outdated technical equipment of processing enterprises.

Economic:

7. The economic mechanisms stimulating recycling-oriented waste management.
8. Strict prohibition of unauthorized dumps.

Organizational:

9. Systematic approach to the problems of processing and disposal of waste updating TSs and regional plans.
10. The red tape preventing business from building sorting and recycling facilities.
11. Compatibility of classifications for goods, waste and transition from waste to product status.

Some ways to solve those problems are provided below.

Information and Knowledge:

1. Awareness raising work with citizens on the importance of separate collection.
2. Consideration of the experience of developed countries and the adoption (with adaptation) of some EU recommendations on waste management.

Technological

3. Improving the quality of separate waste collection and the widespread introduction of technical solutions to achieve this goal (installation of containers for different types of garbage, etc.).
4. Development and implementation of the latest (affordable and environmentally friendly) processing technologies.

Economic:

5. Ensuring conditions preventing the emergence of illegal dumps, and tight control over them.
6. Attracting entrepreneurs to the recycling of waste by creating a comfortable environment for doing business (including legal and tax incentives).
7. Stimulation of enterprises using recycled materials in their activities.
8. Promote independent ERP implementation to large manufacturers.
9. Introduce green public procurement supporting products from secondary raw materials and their producers.

Organizational:

10. Ensure state control (financial and technical) over the collection, removal and disposal of waste.
11. Remove gaps in regulatory documentation.
12. Conducting an inventory (screening) of land allocated for the disposal of waste, to obtain additional raw materials and determine the extent of their impact on the environment and humans.
13. Provide benchmarks for industry in recycling of waste including target indicators.

[17] As confirmed by the Federal Law FZ488.

5. Conclusions and Recommendations

Sustainable Development confirmed in the Agenda 2030 by all member countries of the UN is shaping decisions of individual governments in prioritizing problems and choice of their solutions. The Circular Economy is considered a concept which allows the core issue of SD to be addressed – use of resources today without sacrificing the needs of future generations. Some building blocks of CE are already in place, including enabling factors like international collaboration (G7 Resource Alliance) and example-led change (models of CE like sharing economy and product as a service), as well as reversing cycles and keeping the materials in the economy longer. However, there are barriers on the way towards CE, including organizational, political, economic, and technological.

Whereas use of resources is strongly associated with material production and, ultimately, the wellbeing of the population, SD brings social and environmental aspects into pure economic discourse, stimulating decoupling economic growth from environmental degradation. The former is particularly related to the use of resources, the unsustainability of which is alarming by the need to have two planets Earth in 2030 to satisfy the needs of the growing population.

Still, manufacturing industries are innovating to address the demand of consumers regardless of their level of income by sacrificing quality and durability of products. This inevitably leads to a shorter life of goods and, thus, the materials used for their production are becoming waste very soon, contradicting one of the key principles of CE to keep materials and goods in use. Change in the volume and content of MSW is demonstrating this consumption pattern, as its main source is from the households or alike.

Economic growth is also associated with higher levels of consumption reflected in more generated waste, which is confirmed by statistics. Industrialized nations of the EU report 450 kg of waste per capita annually on average and this number is stabilized[18] or not growing as fast as that of the consumers of Sub-Saharan Africa, where the current rate is going to triple by 2050 (Kaza et al., 2018). Nevertheless, the 3R approach is more naturally applied by less advanced countries, which is considered to be a positive impact of lower income. Having MSW volumes growing is only one part of the problem, another is that managing it requires resources. Poor WM is harmful for both society and the environment, not to mention the negative impact on aesthetics. It contradicts another principle of CE – design out waste and pollution.

[18] Due to policies of waste prevention and better awareness of the population on high consumption consciousness.

Whereas the Circular Economy is by no means limited by waste management practices as there are other factors influencing capacity of products and value of their materials to remain in the economic system like design and models of consumption, CE is strongly associated with WM. The key link between the two is, again, the value retention of materials, but the mechanism supporting this link is very specific – recycling. Waste hierarchy supports keeping products in the cycle (the material value retention goal of CE) promoting waste prevention, which is translated in products reuse[19] and (materials) recycling.

Whereas more advanced countries have state of the art WM systems in place allowing to minimize waste landfilling and recovering material and energy value of up to 90% of MSW, less advanced countries are struggling with the basic goals of WM – protection of human beings and the environment. Nonetheless, embarking on introducing circularity approaches to WM is possible for both groups, although the preconditions are different. The intermediary case is reviewed in the current research on the example of the Russian Federation.

While the country has embarked on the path to improving WM and create state-of-the-art WMS examples which are described in chapter 3, it is also targeting the goals of circularity of materials to be reached in the newly established WMS. Waste reform discussed in Russia already in 2014 has reached its full-fledged implementation scale only in 2019. The key focus of the reform is to create conditions for establishing a recycling industry in the country while keeping waste prevention as the top goal gradually moving to 100% ban on landfilling of recyclable materials in the next decade. Still, regardless the fact that a number of instruments were introduced to reach that goal, including direct support from the head of the State and declaration of support to CE in the terms of reference of the National Ecological Operator[20], a number of factors remain unaddressed.

Inertial and Innovative Scenarios of MSW management for Russia (IFC, 2013) show that the benefits of implementing the current reform might have a similar level of costs as the business-as-usual scenario, but the outcomes are very different. Comparison of pre-reform inert (low recycling waste, 90% landfilling) and current innovative scenarios (the latter being selected by the government to introduce the WR) shows that the active introduction of resources-saving waste management systems with waste minimization and recycling in focus allows "not only to

[19] The part of the cycle, which is already within the WM domain as what is considered waste by one consumer (due to its values) could still be a product for another one.

[20] A state company with a multibillion budget created for that purpose.

reduce the volume of landfilled waste, but also to return over 380 million tons of valuable materials back into the useful (economic) circle at the same time saving the resources which would be necessary to produce them” (ibid.).

However, the overall MSW management system should depart from fixing urgent needs identified by WR to further approximation to CIWMS directly linked to the production system, making manufacturing and design decisions in particular more circular as required by the CE concept. Whereas immediate challenges and solutions for WR are described in chapter 4, the answer to the research question of the current work is dubious. On the one hand, declaration of the overall circularity focus of WMS of Russia is confirmed by the waste hierarchy priorities of the government, as well as by the establishment of the recycling industry. On the other hand, implementation is still at a very initial stage and instruments of new WM realization are weak and already challenging for their practical realization. The overall culture of waste perception and governance issues (including transparency of decision-making and implementation and accountability of authorities at all levels, including prevention of corruption) should also be considered.

One could name the factors of organization (WM is by no means connected to the production system in Russia, where issues of dematerialization or design could be addressed) and financing (unclear Regional WM Operator tariff formation, EPR and PP principle implementation deficiencies) are among the key for circularity elements to be embedded into the WMS. Further barriers on the way are information and knowledge: data is still a big issue for both decision making on waste management, as well as means of reform (and thus circularity) implementation (technologies for recycling; status of secondary resources and products from them; business cases suitable for the country conditions; overall awareness about the need to treat waste through its composition from valuable materials both at the state and individual citizens’ level).

While the issue of separate waste collection remains unsolved, the hope remains as the Russian population supports the implementation of the sorting and separate collection as confirmed[21] by a survey (Levada Center, 2019). Further education and awareness raising on this matter will stimulate a shift to separate collection. While this move triggers an increase in the

[21] 50% of respondents are ready to collect waste separately if they are provided with containers within walking distance, and 16% are already collecting and delivering the waste for recycling despite inconveniences with access to disposal sites.

waste recycling rates, it will also contribute to involving the population in solving the MSW issue. Newly established norms and standards, including recently emerging support and even obligation of manufacturing industries to use BATs, could also serve as a reference for recycling as a preferred strategy for WM at the country level.

Current research work has a number of limitations. Among the key issues are data availability and quality: both on the waste streams and on WR implementation. The former is an issue of data collection and organization in the country, which is also preventing clear understanding even for the government, while the latter is related to the short time passed since the full-fledged launch of the reform in 2019.

The overall CE concept is known in the country's expert community, but its implementation is not reflected in any of country's policies or strategies; whereas there are elements and business models implemented in Russia already driven in a bottom-up approach. Thus, current work was the first attempt to analyze the government-driven steps to the introduction of CE in a very specific sector. Further research would be required to review WR implementation and its concrete impact on recycling-oriented practices of all the actors, including the population and businesses. Bringing the WM experience to a country-level review of conditions to fully introduce CE principles in Russia might be of particular interest.

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Annex 1. Waste Management Toolbox

(a) MSW Management Assessment Framework

According to the waste triangle framework, municipalities could combine *environmental performance* of MSW management system with *total costs* of waste management and the *service performance* to shape their decisions (see Figure 1). Environmental performance includes total waste *generation*, its *recycled portion* as well as *separation activities* (both at the source and as a sorting exercise). *Cost performance* demonstrates monetary side of waste management: all the costs associated with it are considered for the evaluation, including costs of collection and recovery per waste stream. The third angle is associated with the *inhabitants' satisfaction* and behavior as it represents services delivered for waste collection and treatment and includes density of recycling yards and collection frequency.

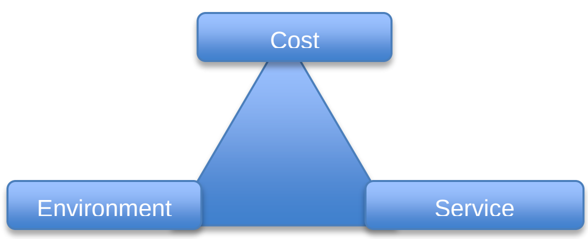


Figure 1. The waste triangle assessment framework (Reuter, Worrell, 2014).

Balancing all the three aspects of waste management is important, whereas it goes without saying that increase in performance on environmental and service parameters inevitably increases the costs.

(b) Including Waste Management System into CE

The main goal of circular economy is to retain value of material in the system. Circular integrated waste management systems (CIWMS) efficiently link "*resource processing and waste treatment to allow the potential of waste to be fully exploited*". This concept is based on recycling technologies ability to either downgrade or upgrade the materials in comparison to their "virgin" state when materials enter the production cycle. Thus, focusing on upgrading technologies allows replacing virgin resources with their equivalent entailing chemical or biological transformation. In case this process is resulting in higher quality products it is called upcycling. In this regard in contrast to existing waste treatment approaches, waste valorization focusing on keeping the value of the waste materials through their transformation into a valuable product or a service.

As such, the CIWMS connects the subsystem of transformation of raw materials into waste (the production system) with the waste treatment subsystem allowing the recirculation of the materials back into the production system. This approach allows capturing the whole cycle of resource transformation from its extraction out of the ecosystem to the value provision during the consumption. Visual representation of the model combining production and waste management systems is below (Figure 2).

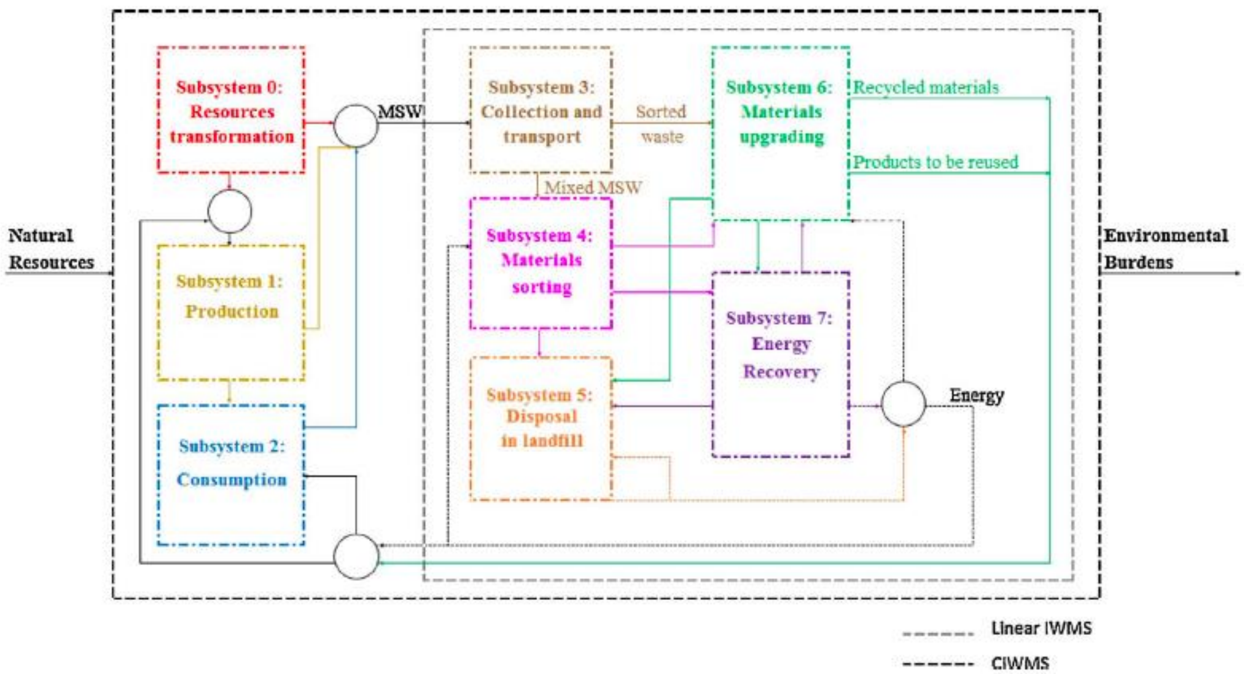


Figure 2. Configuration and boundaries of a CIWMS (Cobo et al., 2017).

While it is clear that this model could mostly be applied to the inorganic waste and also the fact that the primary raw materials of initial production "cannot be compared to the secondary materials produced in the subsystem 6 on a mass basis" (Cobo et al., 2017), value of materials based on their functionality in a transformed format is exactly what allows to keep them in the system without adding to environmental burdens for a much longer time. The latter is considered to be in line with CE concept and, thus, could be taken into consideration by the authorities planning the transition to CE practices and applying elements of it already at the waste management systems level.

(c) Performance Evaluation Methodology

The waste management performance evaluation allows governments to benchmark their efforts against established goals, responsibilities and promises it is giving to the population. While composition of some factors could characterize overall move of the policy towards recovery of value of materials from waste (through, for example, recycling and composting practices), some countries are still landfilling more than 40% of their MSW (Pomberger et al., 2017). Some scholars (Goorhuis, 2011) go further in classifying advancement of countries in waste treatment to VI classes with landfilling >80% as the lowest class and 100% recycling as the top class performance (although with a remark that 100% recycling is not possible in practice).

Assessment of countries' performance benefits from visualisation of waste management data based on Ternary Diagram (TD) which was introduced first at the international level by Prof. Raffaello Cossu based on mathematical theorem by Vincenzo Viviani, which states that the sum of the distances (A, B and C) from any interior point to the sides of an equilateral triangle equals the length of the triangle's altitude (H), i.e. A+B+C=H=3r

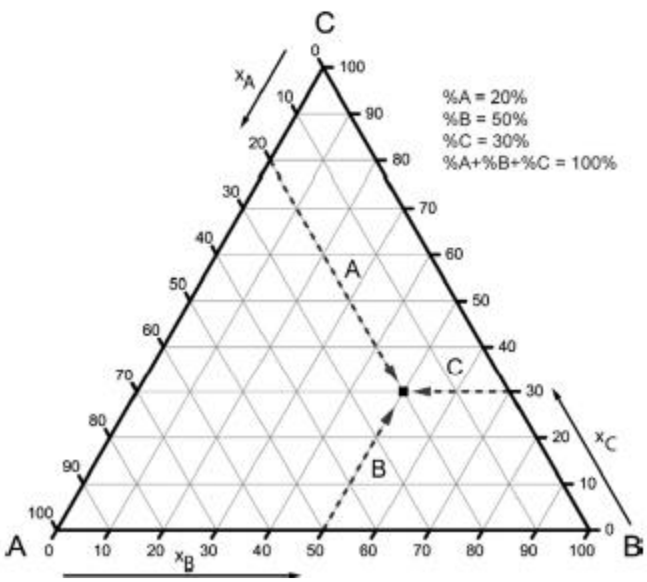


Figure 3. Equilaterak truabgke with three components A, B and C and the plotted point within. Reading instruction: xA=20%; xB=50%; xC=30% (Pomberger et al., 2017)

The Ternary Diagram method applied to waste management is using three sides of the equilateral triangle to represent landfilling (A), incineration (B) and recycling/composting (C) practices of countries. This visualisation allows presentation of positioning, dynamics and development of waste management practices of any analyzed “waste management unit” (company, municipality, city, state etc.) Example of application of this diagram to the EU28 states in year 1995 is provided below on Figure 4.

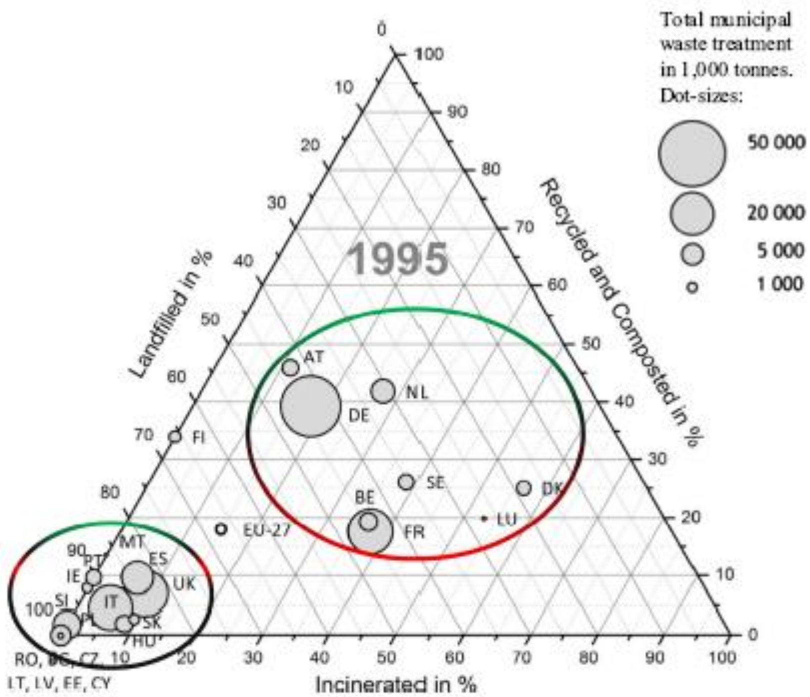
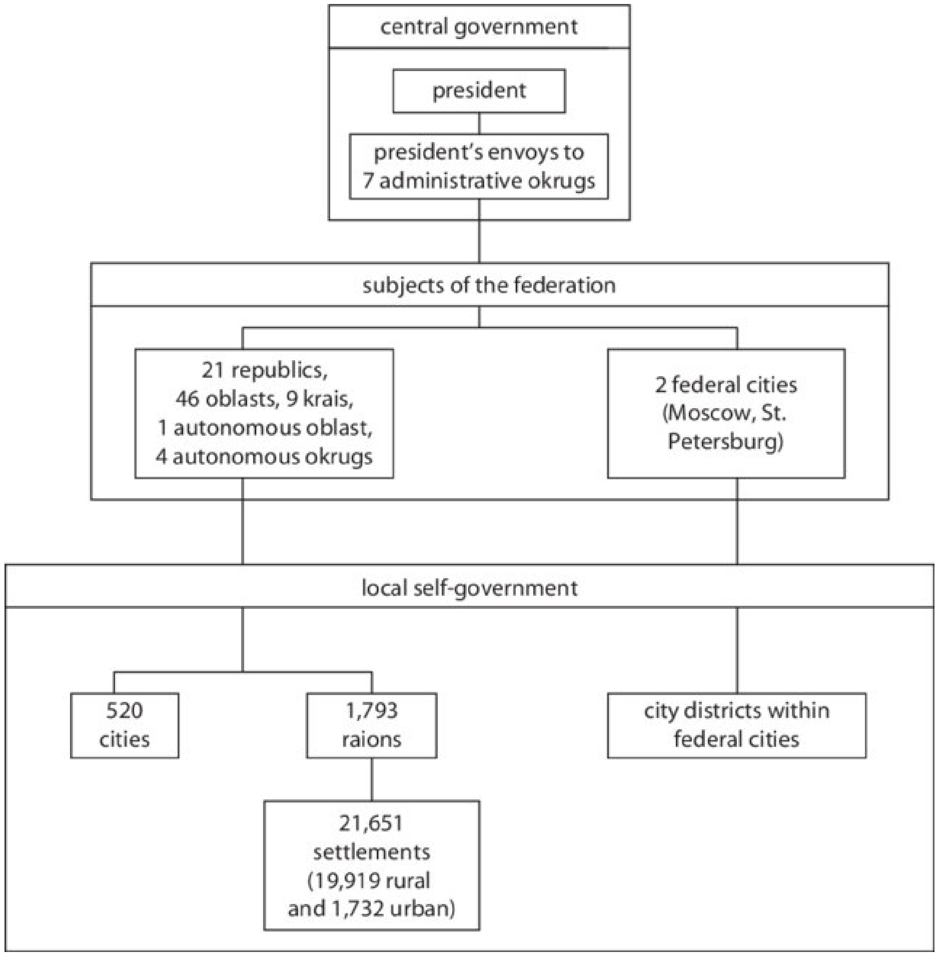


Figure 4. Evaluation of municipal waste management performance of single member states and EU 27, data for 1995 plotted as Ternary Diagram considering total municipal waste treatment in 1000 tonnes by different dot sizes. (Ibid.)

Combining the waste treatment classification and the TD shows that countries which recycle more are distributed in the higher part of the triangle. Further performance dynamics assessed on the basis of Eurostat data collected till 2014 (see the chapter 3.3.) shows tendency of better performing countries to move further up and “lower classed” countries to increase their class. This visualisation confirms the EU policy towards eliminating landfills and increasing the recovery rates, although energy recovery (represented by the “incineration” side of the triangle) is not a desirable outcome of waste management policy.

Annex 2. Federal Structure of Russia



Source: World Bank, 2009