Social-ecological-economic efficiency assessment of the existing scheme of communal solid waste handling in St. Petersburg

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2011

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ABSTRACT

In this paper we consider the existing scheme of communal solid waste handling in St. Petersburg. We assess the efficiency of the scheme by social, ecological and economic criteria. The results of this assessment allow us to conclude that all stages of communal solid waste handling in the city (collection, hauling, processing and disposal of wastes) are profitable. However, the level of waste recycling in the city is low in comparison with the industrially developed countries. Increasing the level of waste recycling up to 40 % by the development of recyclable materials receiving centers, of waste processing facilities, of recoverable resources market will make all stages of the waste handling scheme profitable even without payments from the city population.

Keywords: Communal Solid Wastes, St. Petersburg, Waste Handling Efficiency, Social-ecological-economic Assessment of Efficiency

JEL classifications: R53, O18, Q5, Q53, P25, P28

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The problem of communal solid waste (CSW) handling is highly relevant for all cities on the globe, especially for metropolises, one of which is Saint Petersburg. On the one hand, CSW handling is a profitable business attracting many entrepreneurs; on the other hand, it is an important sphere of municipal services, and its level of development has a significant influence on the standard of city residents' life and the quality of urban environment.

Solving that problem requires, first of all, an analysis of the current scheme of collection, hauling, recycling, burial of waste in order to detect its weaknesses and strengths, to find ways of further development. At the same time, the mentioned diverse nature of the problem, clash of conflicting interests require a multicriteria approach.

The objective of the present research is to determine the efficiency of the existing CSW handling scheme in Saint Petersburg based on social, environmental, and economic criteria.

Accomplishment of that objective should start from defining the notion of communal solid waste. Communal solid waste (CSW) comprises waste produced in residential and public buildings, facilities for trade, entertainment, sports, etc. (including waste from running repair of apartments), waste from heating units of domestic heating, sweepings, fallen leaves collected in yards, pre-consumer waste from manufacture, waste similar to CSW, and bulky waste.

Regarding the information base of the research, it should be mentioned that the data on the parameters describing CSW handling in Saint Petersburg is collected and systematized in no centralized manner; therefore, finding the values of many parameters was difficult. The sources of information for estimating cost-efficiency were the official website of the Territorial Body of the Russian Federal State Statistics Service for Saint Petersburg and Leningradskaya Oblast (Petrostat), the website of the Saint Petersburg City Administration, websites of municipal entities of the city, legal documents, namely Letter № 01-22-2004/10-0-0 of the Tariff Committee of Saint Petersburg dated 28.7.2010 "On Changing the Rate for Housing Maintenance and Repair in Saint Petersburg." When the official sources provided no data, it was taken from expert analyses made based on comparison of similar objects.

In 2010 in Saint Petersburg, approximately 10.5 mio. cu m of communal solid waste were generated, of which 7.5 mio. cu m were consumer waste, and the rest (3.0 mio. cu m) were waste of businesses and organizations operating in the city.

In Saint Petersburg, waste is collected and hauled by many haulage companies, the largest one is Avtopark №1 Spetstrans OAO, and Avtopark № 6 Spetstrans OAO. To reduce transport costs, and to increase the portion of recovered secondary resources, this stage of handling waste has haulage companies use waste sorting and transshipping stations distributed throughout the city.

At present, Saint Petersburg has eight functional waste transshipment stations, of which Avtopark № 1 Spetstrans OAO runs three, Avtopark № 6 Spetstrans — another three, and

Kolpinskaya Avtobaza Spetstrans OAO and Petrogradskaya Avtobaza Spetstrans — one each. In 2010, one waste transshipment, baling and sorting station was commissioned, it belongs to Kvantum OOO.

The main companies specializing in mechanized processing of CSW in Saint Petersburg are Saint Petersburg State Unitary Enterprise "Factory for Mechanized Processing of Communal Waste" (MBPO-2) and its branch "Pilot Plant MPBO" (MBPO-1). Those companies recycle about 20% of all CSW produced in the city, the other 80% of waste is buried in solid waste landfills (SWL) without any mechanized processing.

Moreover, mechanized processing leaves an unprocessed residue of about 15% of the initial mass of CSW incoming to be processed. That residue is also buried in SWL.

Saint Petersburg CSW is buried both on the territory of the city (in SWL-3 Novosyolki), and on the territory of Leningradskaya Oblast (in SWL-1 Yuzhny (Complex Waste Processing Plant ZAO), SWL-2 Severnaya Samarka (Promotkhody ZAO), in the landfill of Novy Svet — EKO OOO, Polygon TBO OOO (Leppisaari), Vuole–Eco ZAO). Unfortunately, part of waste ends up in unauthorized dumps.

The quantities of collected, hauled, and buried CSW in Saint Petersburg in 2010 are given in Fig. 1.

Let us make an efficiency assessment of the above scheme of CSW handling. To do so, the relevant criteria have to be identified.

The officially approved Concept of Handling Communal Solid Waste in the Russian Federation (MD 13-8.2000) states that the main problem of reforming the housing and public utilities is its transfer to nonsubsidy operation. The following course for solving this problem is proposed:

- implementation of complex mechanization of urban sanitation, improvement of the engineering level, reliability, reduction of steel intensity in all groups of machinery and equipment;
- two-stage waste haulage system;
- maximum possible recovery, reclamation;
- environmentally friendly recycling and warehousing of the remainder of waste;
- development of recyclable materials market;
- rewarding tax, load, and amortization policies in the sphere of communal solid waste handling;
- implementation of the system of government registration and control of collection, haulage, decontamination, and warehousing of CSW;
- optimization of rates on collection, haulage, and recycling of CSW;

- reduction of service prices for individuals and increase of efficiency of the CSW management system.

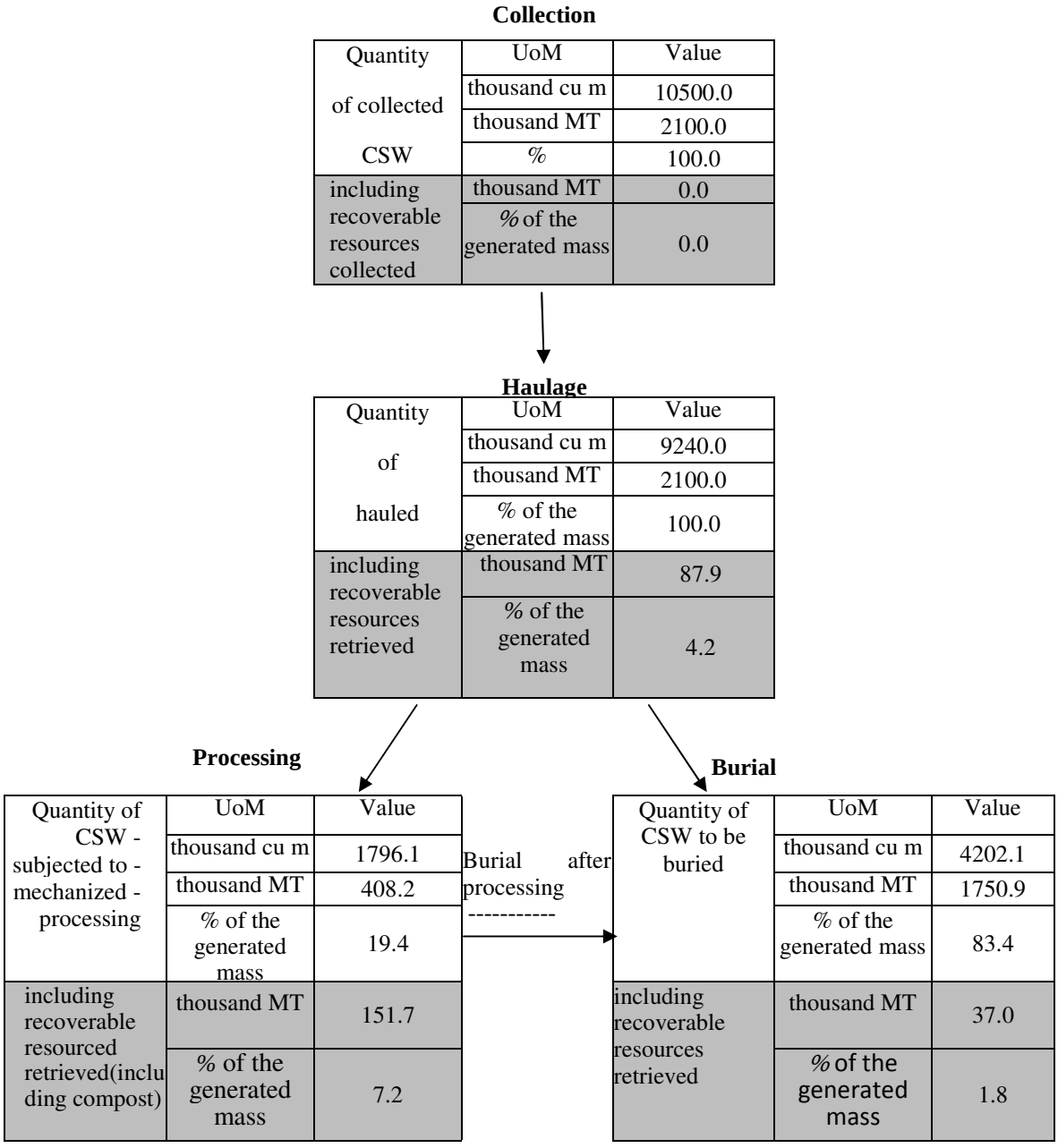

Fig. 1. CSW Handling,
Saint Petersburg, 2010

Unfortunately, work on many of those issues is in the initial stage. Still, they give an idea of the main tendencies of the national policy on CSW handling: maximum waste recycling, decrease of negative impact of waste on the environment, self-sufficiency of companies involved in this sphere, reduction of tariffs for individuals.

Based on the above mentioned issues we can single out the following criteria for efficiency assessment of CSW handling:

Criterion 1. Waste recycling level. The level of usage of waste as recoverable resources should be raised as high as possible;

Criterion 2. Cost-efficiency of stages of CSW handling. Increase in cost-efficiency of funds used in the sphere of CSW handling. Transfer of the municipal service branch handling CSW to nonsubsidy operation. Reduction of the financial burden on individuals and businesses related to paying for CSW handling services (collection, removal, recycling, and burying) due to increase of return on sales of recoverable resources;

Criterion 3. The level of negative impact of waste on the environment. Reduction of negative impact of waste on the environment and decrease of the area of urban lands alienated for burying and utilizing waste.

Since these criteria cover social, economic, and environmental aspects of CSW handling, the efficiency assessment made in the present work can be called social-environmental-economic.

Now, let us dwell on each of the above criteria.

Waste Recycling Level

It is proposed to measure the level of usage of waste as recoverable resources by means of the following factors:

a) portions of retrieved recoverable resources ($D_{ret.}$) in the total amount of produced CSW:

$$D_{ret.} = \frac{M_{r.r.}}{M_{prod.}} * 100\% \qquad (1)$$

where, $M_{r.r}$ is the mass of retrieved recoverable resources on all stages of CSW handling;

$M_{prod.}$ is the total mass of produced waste;

b) portions of waste ($D_{rec.}$) sent to mechanized processing in the total amount of produced waste:

$$D_{rec.} = \frac{M_{rec.}}{(M_{prod.} - M'_{r.r.})} * 100\% \qquad (2)$$

where, $M_{rec.}$ is the mass of waste to be recycled;

$M'_{r.r.}$ is the mass of retrieved recoverable resources at the stages of CSW collection and haulage.

The analysis of the current waste handling scheme (see Fig. 1) gave the following values of the above mentioned factors for Saint Petersburg):

a) $D_{ret.}$ = (279.7 thousand RUR / 2,100.0 thousand RUR) · 100% = 13.3%

In industrialized EU countries the amount of retrieved recoverable resources was 30%–40% as early as in 1998. The level of recyclable materials retrieval depends on the level of organization

of the waste handling process in Saint Petersburg, and in the long run it can reach **up to 50%** of total amount of CSW and commercial waste.

b) $D_{ret.}$ = (408.2 thousand MT / (2,100.0 thousand MT – 87.9 thousand MT)) · 100% = 20.3%

To maximize CSW recycling, the portion of waste sent for mechanized processing should be raised to 100%, i. e. all waste should first be recycled, and only the remainder left after recycling should be taken to landfills.

Thus, none of the factors has the highest possible values. To reach the level of developed countries, the actual portion of retrieved recoverable resources should be increased at least 2.5 times, and the actual portion of waste sent for recycling – 5 times.

Cost-Efficiency of Stages of CSW Handling

Regarding the scheme of CSW handling, cost-efficiency is determined as the ratio between the scheme's expenditure and effect indicating value surplus of profits due to its implementation [2]. The common rule for a normal economic solution is excess of profits (P) over expenses (E)[1]:

$$\mathrm{Eff} = \frac{\mathrm{P}}{\mathrm{E}} \succ 0 \qquad (3)$$

For efficiency assessment of the current CSW handling scheme in Saint Petersburg, the following factors are suggested: production profitability, profitability of capital investments ($P_{cap.}$), and their payoff period ($T_{pp.}$).

Production profitability is determined as the ratio of sales profit to the sum of production and selling costs. In the context of the present issue, companies involved in the sphere of urban sanitation receive profits from selling recoverable resources, services in collecting, hauling, and burying waste. The formula for calculation of production profitability per year t ($\mathrm{P}_{\mathrm{t}}^{\mathrm{profitab.}}$) will be as follows:

$$\mathrm{P}_{\mathrm{t}}^{\mathrm{profitab.}} = \frac{(R_t - (E_t + I/T_{ol.}))}{(E_t + I/T_{ol.})}, \qquad (4)$$

where, $T_{ol.}$ is the operating life of the fixed assets; E_t is expenses of companies involved in the sphere of urban sanitation, over year t; R_t is revenues of companies over year t; I is total capital investments of companies involved in the sphere of waste handling over the entire period of their construction and commission.

In estimation of the production profitability index, it is assumed that companies charge depreciation expenses linearly.

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[1] Prof. Girousov, E. V., Prof. Lopatin, V. N., ed. *Ecology* and Economics of Nature Management: Course book. Moscow: YUNITI-DANA, Yedinstvo, 2003, 203 p.

Production profitability is determined as the average over the whole period of the object's existence, including its construction and operation. Salvage value of the company is assumed to be zero.

Profitability of capital investments ($P_{cap.}$) and *their payoff period* ($T_{pp.}$) are calculated by the following formulae:

$$P_{cap.} = \frac{(\sum_{t=1}^{T_{o.l.}} (P_t - E_t) / T_{o.l.})}{I} \qquad (5)$$

$$T_{p.p.} = \frac{I}{(\sum_{t=1}^{T_{e.l.}} (P_t - I_t) / T_{o.l.})} = \frac{1}{P_{cap.}}. \qquad (6)$$

Approximate calculation of cost-efficiency of the current waste handling scheme in Satin Petersburg is given in Table 1:

Table 1

Estimation of Cost-Efficiency of the Current Waste Handling Scheme in Saint Petersburg as of 2010

No.	Parameter	UoM	Stage of CSW handling			
			Collection	Haulage (including sorting at waste sorting and transshipping stations)	Mechanized (mechanic-biological) processing	Burial in landfills
1.	Capital investments	RUR/MT	42.3	1640.0	7619.2	400.0
		mio. RUR	88.7	3444.0	3110.2	700.3
2.	Operating life of fixed assets	years	5	8	25	30
3.	Operating expenses	RUR/MT per year	82.2	736.0	914.3	120.0
		mio. RUR per year	172.6	1545.6	373.2	210.1
4.	Revenues, including	mio. RUR per year	667.2	3786.0	704.1	1307.8
4.1.	tariff for individuals*	RUR/sq. m. of total area per year	6.16	26.52	11.64	11.64
		mio. RUR per year	667.2	2,874.3	238.5	1023.1
4.2.	average tariff for businesses and organizations (VAT exclusive)**	RUR/MT	-	998.5	1041.2	303.9
		mio. RUR	-	593.5	120.3	150.6
4.3.	sales of recoverable resources	mio. RUR per year	0.0	318.1	312.6	134.1
4.4.	compost sales	mio. RUR per year	-	-	32.7	-
5.	*Gross profit*	*mio. RUR per year*	476.9	1809.9	206.5	1074.3

End of Table 1

No.	Parameter	UoM	Stage of CSW handling			
			Collection	Haulage (including sorting at waste sorting and transshipping stations)	Mechanized (mechanic-biological) processing	Burial in landfills
6.	*Production profitability*	*rel. unit*	2.5	0.9	0.4	4.6
7.	*Profitability of capital investments*	*rel. unit*	5.6	0.7	0.1	1.6
8.	*Payoff period of capital investments*	*years*	0.2	1.5	9.4	0.6

* Tariffs for individuals are listed as per Letter № 01-22-2004/10-0-0 of the Tariff Committee of Saint Petersburg dated 28.7.2010 "On Changing the Rate for Housing Maintenance and Repair in Saint Petersburg."
If citizens are granted utility payment concessions, funds not received by companies providing services to users are compensated from the municipal budget. Consequently, companies recover costs of services rendered to users in full, regardless of concessions and their size;
** The tariff for businesses and organizations varies depending on the company rendering the relevant services. The average tariff rate is used in calculations.

The calculation of cost-efficiency of the current waste handling scheme given in Table 1 is done by stages: collection, haulage, mechanized processing, and burial of waste. Efficiency was assessed from the point of view of commercial interests of companies involved in those stages.

When calculating the value of unit capital investments at the collecting stage, costs of building trash container lots, purchasing trash containers, overhead costs were factored in. At the haulage stage capital investments included not only costs of arranging waste haulage (purchasing dumptrucks, construction of garages for them, etc.), but also costs of construction and commission of waste transshipment and sorting stations functioning in Saint Petersburg.

At the CSW collection stage, operational costs include janitors' payment for cleaning trash container lots and chutes, costs of their running repairs, cleaning and disinfection, as well as overhead costs.

At the waste collection stage, return on sales of recoverable resources produced from CSW is taken as zero because at present in Saint Petersburg centralized collection of recyclable materials (through a system of separate CSW collection) is virtually non-existent. As a rule, municipal entities responsible for garbage collection on their territory do not collect recoverable resources. At this stage, recoverable resources are collected mainly by low-income citizens.

Estimation of cost-efficiency of the current CSW handling scheme in Saint Petersburg by stage with consideration of the above facts has the following results (see Table 1):

1. All stages of communal solid waste handling are profitable, and the CSW collection stage is super-profitable. The payoff period of capital investments at this stage is approximately two months.

2. The least attractive in terms of companies' commercial interest is mechanized CSW processing carried out by two plants of the State Unitary Enterprise "Factory for Mechanized Processing of Communal Waste." Plants require great capital investments and operational costs. But only such plants can perform deep processing of waste with maximum reclamation of recoverable resources.

3. Tariffs on CSW removal, recycling, and burial for individuals do not cover actual expenditure of companies performing those works. Thus, even though the most costly is mechanized waste processing, the highest tariff is set on CSW removal. Tariffs on waste processing and burial are the same, although the corresponding expenses differ considerably;

4. Tariffs on CSW removal, recycling, and burial for businesses and organizations correlate with the actual expenses of the corresponding companies.

5. Charging businesses and companies for CSW processing almost 3.5 times more than for burial renders waste recycling excessively expensive. It is cheaper for companies to have CSW removed to a CSW landfill than to a waste recycling plant. This ratio causes lack of incentives to raise the recycling level and requires government regulation[2].

To determine how much different factors included in the calculation influence profitability of each CSW handling stage, let us analyze response of the resulting parameters (see Table 2).

Table 2 demonstrates that increase of capital investments and operating life of fixed assets has the biggest impact on the change in gross profit and production profitability of waste recycling plants requiring considerable initial investments.

Since the CSW collection and burial stages do not require significant capital investments, gross profit and production profitability of companies involved in those stages little depend on changes in the value of those parameters.

From Table 2 it can also be concluded that the value of the tariff for individuals has a noticeable influence on the profitability figures of companies involved in all CSW handling stages. Trucking companies' profitability figures display especially strong dependence — as compared to other stages — on the value of the tariff because the CSW removal for individuals is the highest (as compared to the tariff on CSW collection, recycling, and burial). Thus, growth of CSW removal tariffs by 10% increases waste haulage companies' gross profit by 18%.

Growth of tariff for businesses and organizations has a smaller impact (as compared to change of tariffs for individuals) on the increase of the profitability parameters in question.

A noticeable influence on profitability growth of waste recycling plants is exerted by increased portions of retrieved recoverable resources and increase in their prices. It happens because

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[2] *Tietenberg T.*, Environmental and Natural Resource Economics (7th Edition). - Colby College, USA, 2005. - p. 183

the technology used at the plants involve very deep processing of CSW, which is not possible at any other stage of CSW handling (be it waste recycling plants or CSW landfills), and, accordingly, the level of production of recoverable resources at this stage is the highest.

Table 2

Analysis of Response of Cost-Efficiency Parameters of the Current CSW Handling Scheme in Saint Petersburg

(as of 2010)

No.	Parameter	Stage of CSW handling			
		Collection	Haulage (including sorting at waste sorting and transshipping stations)	Mechanized (mechanic-biological) processing	Burial in landfills
1.	*Change of the following parameters with increase of unit capital investments (RUR/MT) by 10%:*				
1.1.	Gross profit	-0.4%	-2.6%	-5.7%	-0.2%
1.2.	Production profitability	-1.2%	-4.4%	-8.0%	-1.2%
1.3.	Profitability of capital investments	-9.1%	-9.1%	-9.1%	-9.1%
1.4.	Payoff period of capital investments	10.0%	10.0%	10.0%	10.0%
2.	*Change of the following parameters with increase of operating life of fixed assets (years) by 10%:*				
2.1.	Gross profit	0.3%	2.4%	5.2%	0.2%
2.2.	Production profitability	1.2%	4.2%	7.6%	1.1%
2.3.	Profitability of capital investments	0.0%	0.0%	0.0%	0.0%
2.4.	Payoff period of capital investments	0.0%	0.0%	0.0%	0.0%
3.	*Change of the following parameters with increase of tariff for individuals (RUR/sq. m. of total area per year) by 10%:*				
3.1.	Gross profit	14.0%	18.2%	11.5%	9.5%
3.2.	Production profitability	14.0%	18.2%	11.5%	9.5%
3.3.	Profitability of capital investments	13.5%	14.4%	7.3%	9.3%
3.4.	Payoff period of capital investments	-11.9%	-12.6%	-6.8%	-8.5%
4.	*Change of the following parameters with increase of unit capital investments (RUR/MT) by 10%:*				
4.1.	Gross profit	-	3.6%	5.5%	1.3%
4.2.	Production profitability	-	3.6%	5.5%	1.3%
4.3.	Profitability of capital investments	-	2.9%	3.5%	1.3%
4.3.	Payoff period of capital investments	-	-2.8%	-3.4%	-1.3%
5.	*Change of the following parameters with increase of recoverable resources sales proceeds (mio. RUR per year) by 10%:*				
5.1.	Gross profit	0.0%	1.9%	14.4%	1.2%

End of Table 2

No.	Parameter	Stage of CSW handling			
		Collection	Haulage	Mechanized processing	Burial in landfills
5.2.	Production profitability	0.0%	1.9%	14.4%	1.2%
5.3.	Profitability of capital investments	0.0%	1.5%	9.1%	1.2%
5.4.	Payoff period of capital investments	0.0%	-1.5%	-8.4%	-1.2%
6.	*Change of the following parameters with increase of the portion of retrieved and sold recoverable resources (in percentage of the total CSW mass at a given CSW handling stage) by 10%:*				
6.1.	Gross profit	0.0%	1.9%	12.7%	1.0%
6.2.	Production profitability	0.0%	1.9%	12.7%	1.0%
6.3.	Profitability of capital investments	0.0%	1.5%	8.1%	1.0%
6.3.	Payoff period of capital investments	0.0%	-1.5%	-7.5%	-1.0%

Thus, profitability estimation analysis of the companies involved in CSW handling in Saint Petersburg as per 2010 revealed that all stages of waste handling are profitable, and stages with smallest initial investments (waste collection and burial) have maximum profitability.

The biggest influence on companies' profitability figures is exerted by return on sales of recoverable resources, and tariffs for individuals; profitability of waste recycling plants is also strongly influenced by the size of initial investments and operating life of fixed assets.

Uneven distribution of revenues between CSW handling stages causes private interest to focus on the more profitable stages — waste collection, haulage, and burial — and puts plants of mechanized CSW processing in decline. Private companies are interested in maximizing their profits by increasing return of sales of easily retrievable recoverable resources, reducing transport costs, saving on environmental protection measures. At the same time, socially important CSW recycling projects are not implemented because they are not as commercially attractive. The author believes that without the government regulation of the CSW handling sphere aimed at creating a system of solid waste handling as a unified municipal service branch that would ensure balance between private and social interest, the problem of CSW recycling cannot be solved.

Speaking about the social aspect of efficiency of the current CSW handling scheme in Saint Petersburg, the following needs mentioning.

Apart from tariff payments from individuals and businesses and organizations, companies involved in CSW handling receive financial aid from the Saint Petersburg budget. Thus, in 2010, a total of 1164.0 mio. RUR was allocated to CSW handling in the municipal budget (according to Law of Saint Petersburg No. 605-104 dated 03.12.11 "On the Budget of Saint Petersburg for Year

2010 and the Planning Period of 2011 and 2012"), of which 450.6 mio. RUR — to waste collection and haulage, 212.6 mio. RUR — to waste recycling and burial, 500.8 mio. RUR — to urban sanitation management.

Thus, city residents pay for CSW handling both directly via tariffs, and indirectly via tax and non-tax payments to the budget of Saint Petersburg. In 2010, total financial burden of waste handling per one city resident was 1,289.6 RUR (107.5 RUR per month), including tariffs on CSW collection, removal, recycling, and burial — 1,038.0 RUR (86.5 RUR per month).

By approximate calculations, raising the total portion of retrieved recoverable resources at all stages of CSW handling from 13% to 40% will make all stages (CSW collection, haulage, recycling, and burial) profitable without levying tariffs from individuals.

Level of Negative Impact of Waste on the Environment

Waste is a source of pollution of atmospheric air, surface and underground water, and soil. Generally, the estimated figure of negative impact of waste on the environment is taken as its volume situated on the territory of the city. By pre-estimates, in the end of 2010 waste landfills in Saint Petersburg both in the city and in Leningradskaya Oblast held approximately **115 mio. cu m** of waste, including:

- approximately 41.1 mio. cu m buried in CSW landfill Yuzhny;
- 13.2 mio. cu m in CSW-2 Severnaya Samarka (Promotkhody ZFOZ);
- 42.0 mio. cu m in CSW-3 Novoselki;
- 3.5 mio. cu m in landfill Novy Svet - ECO OOO;
- 5.5 mio. cu m in the landfill of Polygon TBO OOO (Leppisaari);
- 5.0 mio. cu m in the landfill of Vuole–Eco ZAO;
- 4.5 mio. cu m in closed city dumps (Kronshtadskaya, Ugolnaya Gavan);
- 0.5 mio. cu m in unauthorized dumps.

By the and of 2010, there were about **50 mio. cu m** of refuse in Saint Petersburg. Considering that, according to the Committee on Land Resources of the Government of Saint Petersburg, the total area of the city is 139.9 thousand ha (as of the 1st of January 2010), and there is approximately 340 cu m of refuse per each ha of the city's territory.

CSW burial sites require significant plots of land. Beside the territory of the facility itself, the area of sanitary protection is alienated, which is set for the purposes of public safety around sites and facilities affecting human habitat and health. The size of the areas of sanitary protection, procedure of its determination, and the usage mode of the areas are regulated by Sanitary Regulations and Standards (SanPiN) 2.2.1/2.1.1.1200-03 "Areas of Sanitary Protection and Sanitary Classification of Enterprises, Buildings, and Other Objects."

The area of the main CSW burial sites in Saint Petersburg are listed in Table 3.

Table 3

Area of CSW Burial Sites

in Saint Petersburg

No.	Object:	Covered area, ha	Size of the area of sanitary protection, m	Area of the sanitary protection, ha	Total area of the facility and its area of sanitary protection, ha
1.	CSW landfill Yuzhny	29.7	500	189.1	218.8
2.	SWL-2 Severnaya Samarka	61.0	1000	636.9	697.9
3.	SWL-3 Novosyolki	83.5	500	264.8	348.3
4.	CSW landfill Novy Svet — EKO OOO	14.2	500	155.0	169.2
5.	Polygon TBO OOO (Leppisaari)	10.0	1000	553.8	563.8
6.	CSW landfill Vuole–Eco ZAO	20.0	300	89.8	109.8
7.	*Closed city dumps, including*	*113.0*	-	*1,084.9*	*1,197.9*
7.1.	Ugolnaya Gavan (ul. Marshala Kazakova)	108.0	1,000	684.9	792.9
7.2.	Kronshtadskaya (Kronshtadskoye shosse)	5.0	1,000	400.0	405.0
8.	Unauthorized dumps in Saint Petersburg (approximately)	4.0	1,000	330.0	334.0
	Total:	**335.4**	**-**	**3,304.3**	**3,639.7**

According to the above calculations, the area occupied by facilities storing CSW is 335.4 ha, including **200.5 ha** in Saint Petersburg. The resulting value of the area is important for a city pressed for spacial resources.

Moreover, considering that the area where CSW burial sites affect the environment and public health is much larger than the area of their plots of land, the areas of sanitary protection of CSW burial sites should also be factored in. Then, together with their areas of sanitary protection, the area alienated for facilities storing CSW is 3639.7 ha, including **1,880.2 ha** in Saint Petersburg.

The above approximate calculations entail the following **conclusions**:

1. The current CSW handling scheme in Saint Petersburg is characterized by a lower level of recoverable resources retrieval than that in industrialized countries (about 13% vs. to 30-40% in industrialized nations). Increase of recyclable materials retrieval will reduce the load on the

environment due to bringing back to economic turnover the resources that were previously excluded from it and served to deteriorate the environmental situation in the city.

2. The current system of CSW handling in Saint Petersburg is characterized by a lower level of mechanized processing of communal waste as compared to that in developed countries (20.3% by a preliminary estimate), it can be raised even without building new waste recycling plants, through upgrading Saint Petersburg State Unitary Enterprise "Factory MBPO-II" (MBPO-2) and its branch "Pilot Plant MPBO" (MBPO-1).

3. On the whole, the scheme of CSW handling in Saint Petersburg is profitable even without budget financing. Most profitable are the stages with the lowest initial investments — waste collection and burial. A considerable influence on companies' profitability figures is exerted by return on sales of recoverable resources, and tariffs for individuals; for waste recycling plants it is the size of initial investments and operating life of fixed assets.

By preliminary estimates, raising the total portion of retrieved recoverable resources from 13% to 40% will make all stages of CSW handling profitable without levying any tariffs from individuals.

4. Each year the growing volume of refuse buried in Saint Petersburg contributes to continuous deterioration of atmospheric air, surface and underground water, and soil in Saint Petersburg and Leningradskaya Oblast. If the accumulated communal solid waste were spread out over the whole area of the city, the layer would be over 3 cm thick.

5. Together with their areas of sanitary protection, the area of Saint Petersburg alienated for facilities storing CSW is 1,880.2 ha, including 200.5 ha of the land of companies involved in waste burying. That is, the area of the territory under negative influence of waste burial sites is over 9 times as large as the area of their plots of land.

Thus, the analysis of the current CSW handling scheme in Saint Petersburg revealed its low efficiency by social and environmental criteria, and high profitability of companies involved in that sphere, especially at the stages of waste collection and burial.

The author believes that, without government regulation, the problem of CSW handling in Saint Petersburg, or in any other metropolis, cannot be solved. And national policy in the city should be aimed at developing a network of recycling centers, upgrading waste recycling plants, reducing tariffs on waste recycling and raising tariffs on their burial, stimulating the city's businesses to use recoverable resources as feed materials in production. Later, when the total portion of retrieved recoverable resources in the total amount of produced CSW exceeds 40%, the sphere of CSW handling will be profitable even without pulling funds from city residents.

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