CONSULTANT'S PROJECTIONS ON WASTE QUANTITIES AND COMPOSITION

BELGRADE WASTE TREATMENT AND DISPOSAL PPP PROJECT

FEBRUARY 2016

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1. Consultant's Estimate on Waste Quantities and Composition

Fichtner, also referred to herein as the Consultant, has reviewed the MSW quantity forecast for Belgrade, together with the City. This document presents the assumptions and results developed by the Consultant.

1.1 Baseline assumptions

1.1.1 Base year waste data

Fichtner's estimate is based on data from 2014.

Fichtner used information collected from PUC Gradska Cistoca's historical data to determine the quantities of different types of waste, as shown in the table below.

Type of waste *(tons)*	2013	2014	
Municipal waste	522,654	543,764	Includes household and commercial waste collected by the PUC
C&D waste	180,111	173,880	
Tires	49	22	
Other	5,462	34,475	Significant increase due to the floods.
Total	708,276	752,141	

Table 1: Gradska Cistoca data for waste quantities

Fichtner made the following adjustments in order to provide a realistic picture of Belgrade municipalities' waste flows that will be part of the project scope in the future.

Parameter	Unit	2014
Belgrade population (*)	Inhabitants	1,503,8101
Municipal Household Waste Increase related to population growth	%/a	0.46
Commercial Waste Increase related to GDP-growth	%/a	1.0%
Municipal Household Waste Quantity 2014 (**)	t/a	462,900
Commercial Waste Quantity 2014 (**)	t/a	151,600
Total waste quantity (**)	t/a	614,500
Waste generation per capita per day 2014	Kg	1.12
Waste generation per capita per year 2014	Kg	409

(*) for the service area comprising total Gradska Cistoca excluding Lazarevac, Obrenovac, Mladenovac and Sopot
(**) including landfilled waste and recyclables

Table 2: Consultant's adjustment for base year 2014 waste data

1.1.2 Waste generation

The Consultant used the following assumptions to create projections of the generated waste quantities until 2046:

- Annual population growth: according to population growth projected by the Statistical Office of Belgrade ranging between 0.46% and 0.59% annually
- Waste generation growth: from 409 kg per capita in 2014 to 425 kg per capita in 2046 (+ 3.9% growth per capita over the period)
- Household/commercial waste shares: 80%/20%
- Household waste:
  - Specific waste generation per inhabitant is assumed to remain constant over the projection period;
  - Total waste quantities from households are increasing with the growth in population (see above)
- Waste similar to household waste (commercial waste): Annual increase of 1% is assumed reflecting increasing quantities driven by economic growth, but less than GDP development projected
- Service area:

- Barajevo and Grocka will withdraw from using Vinca landfill during 2017 at the latest, and shall not be included in the Project's service area.
- Mladenovac and Sopot will join the project's service area when the EfW facilities will start operation, i.e. in 2020.

1.1.3 Waste composition

For the purpose of this analysis the waste composition is assumed to be constant over the period.

Detailed information and data on waste composition surveys carried out from 2012 to 2015 are available on the data site, including an overview of the methodology used to perform the sampling.
The waste composition assumed for estimation of required facility capacities, mass flow and achievement of targets is based on the following data:

- Household waste: waste analysis data 2014 provided to Fichtner based on the regular waste composition assessment conducted by Gradska Cistoca. Results from waste analysis are weighted as follows by Fichtner (assumptions):
  - Rural areas: 10%
  - Individual houses: 20%
  - Blocks of flats referred to as "collective housing" in the waste composition sampling data available on the data site: 70%
- Assumed ratio of household and commercial waste 80%/20%, while commercial waste composition data of Eastern European City is assumed
- Data on already recycled materials were considered in the calculation:
  - 28,500 t/a in 2014 from household sources
  - 54,000 t/a in 2014 from commercial sources

As a result, the baseline waste composition presented in detail in **Appendix – Sheet "Baseline Waste Composition"** is assumed.

1.1.4 Recycling targets

The EU target rates for recycling are:

- Waste Framework Directive: 50% overall MSW recycling (four different calculation methods can be applied; assumed baseline recycling rates for the projection will fulfil this target in accordance with calculation method 2.
- Packaging and Packaging Waste Directive:
  - Specific recycling targets (paper/cardboard, plastic, metal, wood) in accordance with the quota set in the packaging directive to be reached by 2025.
  - Overall recycling target of packaging waste is 55%.

The following recycling rates were assumed for the projection from year 2025 onwards:

	Households	Commercial
Paper/Cardboard	60.0%	70.0%
Plastic	22.5%	40.0%
Glass	70.0%	70.0%
Metal	70.0%	70.0%
Wood	15.0%	50.0%

Table 3: Recycling rates

It is assumed that materials similar to packaging waste such as newspaper, magazines, plastic and metal from household applications will reach the same recycling quota as packaging waste.

Assumptions were made on annually increasing recycling rates up to 2025 as detailed in **Appendix – Sheet "MSW Reduction".** Belgrade has started introducing separate collection in a 2-bin system (residual waste, dry recyclables) and will reach full coverage of the territory of Belgrade by 2020. We assume some years of optimization to fully reach the envisaged recycling rates.

1.2 Results for baseline assumptions

Municipal Solid Waste: projection based on the assumptions set out in the previous section are set out in **Appendix – Sheets "Waste generation forecast" and "MSW reduction"**. The assumptions are marked in blue in these tables.

Construction and Demolition Waste (CDW): Annually 100,000 t/a of soil and 100,000 t/a of other CDW is assumed based on the city's rough estimates.

Green waste: Annually 11,000 t/a are assumed to be collected separately.

1.3 Sensitivity scenarios on potential recycling achievements by 2025

Belgrade is introducing a recycling system which is aimed at achieving high recycling rates, if the population is well informed and motivated. Other countries have demonstrated that high recycling rates are possible.

The baseline recycling estimate are based on optimistic recycling achievements, i.e. assuming highly motivated population who separates carefully and places the materials in the right bins.

The system may be less successful than anticipated. Therefore four sensitivity scenarios are presented herein to show the sensitivity of recycling achievements on the residual municipal waste quantity. The assumptions on recycling rates and results are shown in the following table and figures.

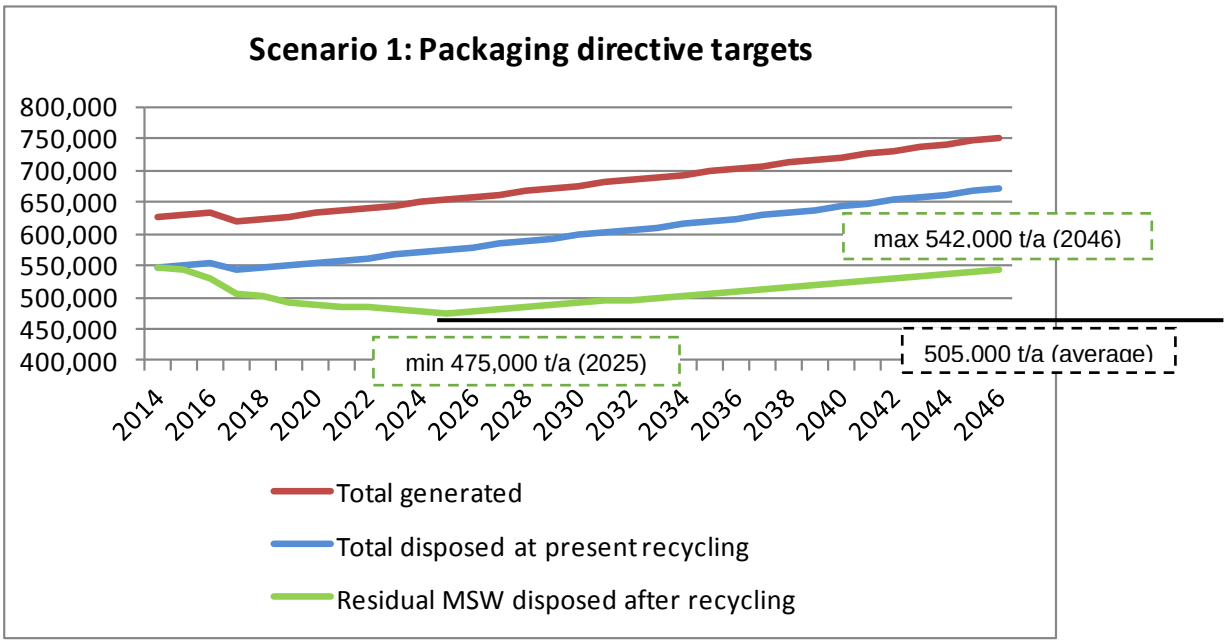
	Average 2025	Households (share of 80%)	Commercial (share of 20%)
Scenario 0: Exact required packaging recycling rates (not suitable: does not fulfill overall target)			
Paper/Cardboard	60.0%	60.0%	60.0%
Plastic	22.5%	22.5%	22.5%
Glass	60.0%	60.0%	60.0%
Metal	50.0%	50.0%	50.0%
Wood	15.0%	15.0%	15.0%
Total recycling	49.4%		
Scenario 1: Required packaging recycling rates for households[1], higher rates at commercial companies			
Paper/Cardboard	64,8%	60.0%	70.0%
Plastic	27.2%	22.5%	40.0%
Glass	63.2%	60.0%	70.0%
Metal	55,7%	50.0%	70.0%
Wood	35,6%	15.0%	50.0%
Total recycling	55.0%		
Average required treatment capacity			505,000 t/a
Estimated calorific value			8.9 MJ/kg
Scenario 2: Average achievement EU27 for packaging recycling 2012 [2], lower rates for households, higher rates at commercial companies. [3]			
Paper/Cardboard	83,9%	78.0%	90.0%
Plastic	35.5%	30.0%	50.0%
Glass	72.8%	70.0%	80.0%
Metal	72.4%	70.0%	80.0%
Wood	38.0%	15.0%	80.0%
Total recycling	70.3%		
Average required treatment capacity			470,000 t/a
Estimated calorific value			8.6 MJ/kg
Scenario 3: Alternative achievable rates in Belgrade			
Paper/Cardboard	74,8%	70.0%	80.0%
Plastic	42.7%	40.0%	50.0%
Glass	73.2%	70.0%	80.0%
Metal	72.8%	70.0%	80.0%
Wood	53.3%	15.0%	80.0%
Total recycling	67.4%		
Average required treatment capacity			475,000 t/a
Estimated calorific value			8.5 MJ/kg

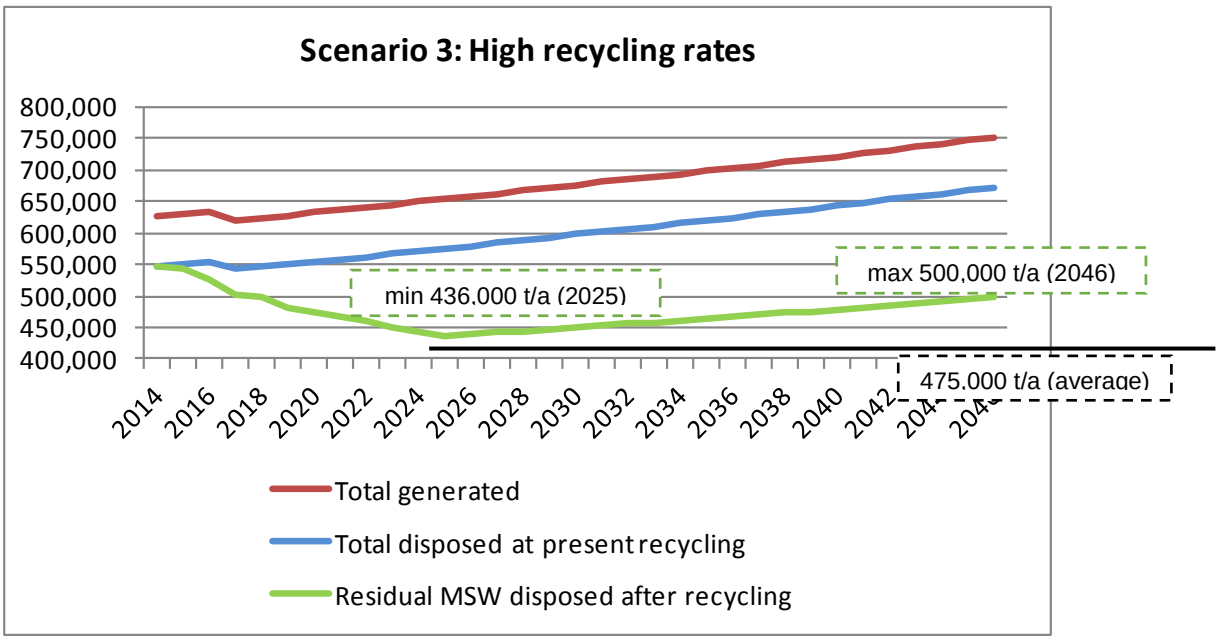
Table 4: Sensitivity analysis on recycling rates

[1] Source: Packaging waste directive average targets

[2] Source: Eurostat: http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

[3] Achieving these rates would require more effort on separate collection of paper/cardboard than it is currently foreseen for Belgrade.





It must be noted that scenario 3 is ambitious, taking into account the collection system in Belgrade.

On the other hand, in order to meet the European requirements securely (i.e. overall recycling target of packaging waste of 55%, MSW recycling target of 50%), slightly higher rates than assumed for Scenario 1 need to be achieved.

2. Appendix contents list (Excel file)

2.1 Notice

2.2 Waste generation forecast

2.3 Baseline Waste Composition

2.4 MSW reduction

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