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Circular Economy Impact Assessment

Plastic Packaging sector

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This impact assessment was prepared by the Center of Advanced Economic Studies (CEVES), led by Danijela Bobić with a team composed of Marko Danon and Marija Suzić. Impact assessment was conducted for three sectors: plastic packaging, electrical and electronic equipment, and HORECA. Authors of particular reports are named on the front page.

This report benefited from comments by participants at consultative meetings, as well as from bilateral meetings with stakeholders.

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List of abbreviations

BAU	Business As Usual
C&I	Commerce & Industry
CEVES	Center for Advanced Economic Studies
EBITDA	Earnings before interest, taxes, depreciation, and amortization
EC	European Commission
EU	European Union
FTE	Full Time Equivalent
GVA	Gross Value Added
HH	Households
ILO	International Labour Organization
NMS	New Member States
PET	Polyethylene terephthalate
PP	Plastic Packaging
PPW	Plastic Packaging Waste
PUC	Public Utility Company
SBRA	Serbian Business Registers Agency
SEPA	Serbian Environment Protection Agency
SORS	Statistical Office of Republic of Serbia

FOREWORD

Unlike the existing business model on which the so-called linear economic system (take-waste-dispose) is based, transforming irreversibly raw materials and products into landfilled waste after use, the circular economy (CE) model seeks to return as much as possible to the production chain and waste considers as raw material. This concept makes a complete shift in business operations of all economic cycle participants and implies waste reduction through new business models, product design, higher production efficiency, changed consumer habits, extended product life, but also greater waste utilization through increased recycling and virtually eliminated landfill waste. Striving towards sustainable use of resources and waste elimination is the basis of this new business philosophy.

Germany incorporated the principles of the circular economy into its legislation in 1996, while the European Union began the transition towards this model in 2015, for circular economy to become an integral part of the relevant legislation and policies in 2017.

In 2015 the GIZ, as part of its projects, launched initiatives as to identify benefits that both the economy and society would benefit from the transition to this model. The analysis and defining of the strategic and institutional framework for the introduction of CE in Serbia, which included setting goals, measures and instruments as well as developing an accompanying Action Plan, was conducted during 2016 – 2017. As a result of this process, three sectors that have the highest potential for implementation of the CE concept were identified: (a) agriculture/HORECA and food waste; (b) packaging waste/plastic; and (c) electrical and electronic waste. For the purposes of the GIZ project the experts Prof. Dr. Marina Ilic from Belgrade and Henning Wilts from the Wuppertal Institute in Germany carried out the analyses, in consultation with relevant institutions and in cooperation with relevant ministries for the environment and the economy, as well as the Serbian Chamber of Commerce.

The next phase of the GIZ project contribution to this process included the development of economic effects analyzes in the defined sectors that by introduction of circular economy would be achieved primarily relating to GDP and job creation. Here we present the results of the analysis for the plastic packaging sector conducted for the GIZ by the Center for Advanced Economic Studies in Belgrade. The findings of this research will serve to further formulate policies and programs towards the transition to circular business models.

GIZ project “Climate Sensitive Waste Management (DKTI)”

INTRODUCTION

Plastics are valuable materials covering a wide range of applications in everyday life and are found everywhere, from households to industry. Being often a more efficient material compared to other (such as metal, wood or glass), use of plastic experienced dynamic expansion over the past decades. Not only that production costs are lower due to higher energy efficiency, the material itself is lighter than alternative materials, and it is less susceptible to damage from chemical reactions such as oxidation or rusting. For example: 1 kg of plastic can deliver 34 litres of a beverage, while 1.4 kg of aluminium, 3.6 kg of steel, or over 18 kg of glass is needed to deliver the same amount of a beverage (Thomas). Similarly, while over 50% of all European packaging in use is made of plastics, they account for only 17% of the total packaging weight on the market (Plastics Europe).

Recent innovation in material properties brought to an even wider application of plastics. Light and innovative materials in transport save fuel and cut CO_2 emissions, bio-compatible plastic materials are enabling medical innovation, while plastic packaging ensures food safety and reduces food waste (European Commission, 2018). Due to the distinctive properties of plastic, as well as its growing applications, the production volume of this material will probably continue to grow. This especially refers to plastic packaging, which is the single most important plastic product. Packaging sector is the largest user of plastics, covering even 40% of total demand for plastics in Europe (ibid.)

However, issue of plastic waste management arises as one of the key challenges related to increasing consumption of plastic products – which particularly threatens environment. Even 44% of total waste generated in the world refers to plastics (World Bank, 2018). At the same time, plastics constitute a growing threat to the environment and human well-being, affecting in particular the world’s freshwater systems and marine resources, as well as terrestrial biodiversity and public health (UNDP, 2019). This particularly arises from the fact that plastics have extremely long decomposition period and thus stay in the environment for a long time. Namely, some plastics take up to even 500 years to break down (STAP, 2018). As recent studies underline, if current linear ‘take, make, use, and dispose’ model continues, there will be more plastics, by weight, in the oceans than fish by 2050 (ibid.).

European Union recognised this issue, since they still have a poor system of plastic waste management. Europe generates around 25.8 million tonnes of plastic waste every year (40% referring to plastic packaging), out of which less than 30% of such waste is collected for recycling (European Commission, 2018). Plastic packaging in particular has somewhat higher, but still low recycling rate of 43%. Additionally, it is important to note that a significant share that accounted as recycled was used to be treated in third countries (ibid.). However, since China, a global leader in waste business, banned plastic and paper waste import in 2018, waste treatment has become a burning issue for the EU.

A circular economy concept was particularly recognised as a pathway to a more sustainable waste management. Unlike linear “take, waste, dispose” model, circular economy introduces *a waste hierarchy* that should radically increase resource efficiency. In terms of plastics, this implies a new plastics economy, where the design and production of plastics and plastic products fully respect reuse, repair and recycling needs and more sustainable materials are developed and promoted (European Commission, 2018). The focus is on prolonged lifespan of products (like an initiative to ban single use plastic bottles), but once the plastics is wasted, it is a priority to be recycled. Plastic products have the potential to be recycled many times while retaining vast majority of their value and functional properties and recycling is considered as the most preferred option for plastics waste.

Introducing circular economy can also create significant social and economic benefits, but it is crucial to establish a sustainable system of waste management. The EU introduced a full legislative package tackling waste management, a strategy particularly focused on increased plastics treatment. It underlines that, essential requirements for circular economy and retention of product and material value refer to adequate waste collection and sorting processes (European Commission, 2019a).

Serbia is still at the beginning of the road in terms of plastic packaging waste management and recycling, but there is a potential. In Serbia, according to the official data of Serbian Environmental Protection Agency, only 22% of plastic packaging is being collected and recycled, while the rest is being wasted. This is much lower compared to EU recycling level of 43%. The major issue refers to poor collection system, and almost no primary selection. The entire recycling sectors relies on secondary selection, which reduces amount of plastics selected for recycling, induces significantly more costs, and reduces its quality due to high share of dirt.

This study provides an impact assessment analysis of implementing circular economy principles in plastic packaging sector in Serbia. The assessment focuses on social and economic impact, by referring to job creation and value-added generation in Serbia. The report itself has three main parts. The first part introduces the methodology for impact assessment. The second part captures the current state in the EU and Serbia. It uncovers the structure of PP waste management value chain in Serbia and its key players and processes. The third part presents the results of the impact assessment analysis. It complements the part 2, by focusing on estimation of the future dynamics in detail.

PART 1. METHODOLOGICAL NOTES

This impact assessment focuses on generation of gross value added (including revenues and operating costs) (*economic aspect*), as well as employment growth (*social aspect*) along entire waste management segment of plastic packaging value chain. In order to achieve recycling targets of 55% by 2030, entire waste management needs to be improved - including PP waste collection, transport, primary and secondary sorting and recycling. Depending on adequacy and efficiency of existing waste management system within a country, these improvements could incur different level of operational costs, but also generate revenues and jobs.

This methodology has been developed by CEVES team and has built on previous studies of which we draw particular attention to Deloitte (2015), Deloitte (2017) and European Commission, (2019a). This study contributes to existing body of research by providing a relatively updated and refreshed position on the issue, as well as an analysis focusing solely on Serbia’s situation.

• Scope of the study

This impact assessment was conducted within specific scope, focusing on the impact assessment of increased plastic packaging recycling from 2019 to 2030. Details on the scope of the study are presented in the following table:

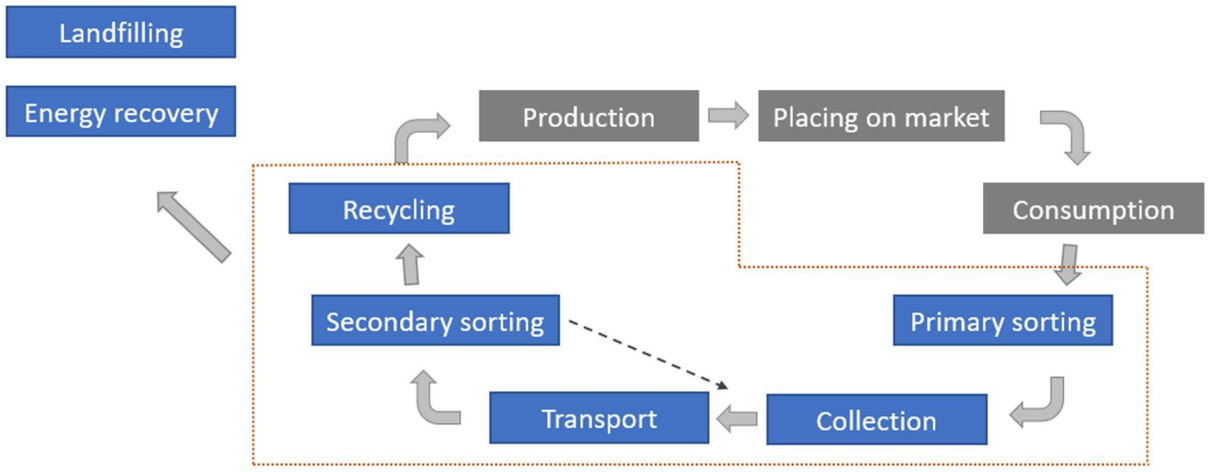
Table 1. Scope of the study

Topic	Scope/Description
Plastic packaging waste types	European Waste Catalogue (EWC) Code: 15 01 02 [PET, foils, plastic bags, bottles, maintenance products, solid food packaging etc.] Wider waste types: PET and OTHER PP Waste origin: industrial, commercial and municipal waste
Players	The assessment covers the waste management segment of value chain: from PP waste generation, to the production of recycled plastic materials
Recycling targets	55% of plastic packaging waste recycled by 2030. This target corresponds to EU targets set in Directive 94/62/EC.
Timeframe	Impact assessment compares cumulative effects during 2019-2030 period compared to baseline year 2018.
Geographical scope	Focus of the study: Serbia Benchmark countries: Bulgaria, Croatia and Romania
Key indicators	Economic indicators: gross value added, revenues, operating costs Social indicators: direct jobs
Value chain segments covered	Assessment covers CE VC segments from the moment PP becomes waste: primary sorting, collection, transport, secondary sorting and recycling (circled blue colour phases on Graph 1)

Plastic Packaging sector has two main value chain segments: PP placing on market and PP waste management. The first value chain segments refer to steps up to PP consumption: production of plastics and plastic packaging, PP placing on market and PP consumption (grey colour on Graph 1). Once the PP is being consumed, it becomes a waste. All steps after consumption refer to waste management which culminate with recycling, energy recovery or landfilling (activities coloured blue on Graph 1). Moving from linear to a circular economy, implies improvements in both segments: from better product design, reduction or ban of single-plastic use, to improved primary selection and higher recycling.

However, this assessment focuses on waste management segment of PP value chain. Ideally, all plastic packaging products that are consumed would be recycled and put back in production of new plastic products or parts. Introducing circular economy concept significantly heavily relies on establishing an infrastructure that would move PP waste from landfilling to recycling. While circular economy could generate potential positive impacts in first phase – for example, firms that are producers of plastic products could profit from cheaper and more available recycled raw materials – assessment of those benefits is out of scope of this engagement.

Graph 1. Circular Economy Value Chain within Plastic Packaging Sector



Note: Impact assessment focuses on the circled blue segment on this figure

- ## Description of the model

This assessment aims to quantify the impact of increased recycling on all PP waste management phases in terms of revenues, operational costs and direct jobs. The model basically implies applying estimated coefficients of revenues, operational costs and direct jobs needed per 10k tonnes of PP waste to be treated along the value chain, to forecasted material waste flows along the same value chain. In order to achieve this, the following main assessment steps are conducted:

- **Understanding the PP waste management value chain structure** – key processes and players. This implies identifying key players along value chain, their size and role in the process, relationships among them, their efficiency (jobs and costs incurred in the process) and profitability (revenues, EBITDA). Finally, it also assumes understanding required improvement needed in order to meet the future recycling targets.
- **Quantifying material flows along the value chain**. This means following PP waste from the moment it is generated till its final treatment either through recycling, energy recovery

or landfilling. Material flows refer to the following indicators: PP placed on market, PP consumed, PP waste generated, PP waste collected, PP waste sorted, PP waste recycled and PPW landfilled (we assume marginal PPW energy recovery).

- **Quantifying revenues, operational costs and direct jobs needed to achieve recycling targets in each VC segment**. For each phase related specific *coefficients* are calculated. These coefficients are estimated in relative terms to PP material quantities (e.g. FTE jobs in recycling - FTE jobs per 10.000 tonnes of PP recycled) (*see* section Parameters used in assessment).
- **Introducing assumptions and assessing impact for two scenarios**: Business as Usual scenario and Target scenario (*see* next section). As previously mentioned, this implies applying coefficients to estimated material flows by 2030.

• Scenarios

This assessment quantifies cumulative impact of introducing circular economy in the period 2019-2030, compared to a *Baseline scenario.* The **Baseline scenario** quantifies key indicators in current state in 2018, which serves as a reference point. Starting from a Baseline point, assessment quantities two scenarios:

- A **“business as usual” (BAU) scenario** implies keeping the current state of waste management system at the same level and putting no additional effort for its improvement. In case of Serbia, this means marginal primary waste separation, poor secondary separation, low recycling rate, low quality of waste and high landfilling rates (including high share of illegal dumping).
- A **“Target” (Target) scenario** implies introducing necessary improvement in waste management system along value chain in order to achieve recycling rate targets by 2030. This includes higher waste collection, improved waste separation and increased recycling. Target scenario will have three sub-scenarios, depending on the level of waste management improvement (*see* Part 3).

These two scenarios provide extreme values for future expectations. BAU scenario refers to the lowest expected level of impact *(lower boundary),* and Target scenario refers to the highest expected level of impact *(upper boundary).* Depending on the level of circular economy implementation, actual impact could take certain values between lower and upper boundaries.

• Parameters used in assessment

This assessment estimates the following parameters:

- PP waste material inputs through PP waste management value chain in weights (in tonnes). The assessment covers separately two types of PP: PET bottles and other PP.
- PP waste outputs from recycling process in weights (in tonnes).
- **Efficiency of separate sorting process (in %).** This parameter covers the share of primary sorting process, and the secondary sorting process as a residual needed to reach recycling targets by 2030.
- **Efficiency of recycling process - recycling yields (in %).** These yields are estimated as average values for recycling outputs of PET bottles and other PP.
- Revenues per 10k tonnes of PP waste in each observed phase.

- Operational costs per 10k tonnes of PP waste in each observed phase.
- **Input costs.** These are estimated as average values for PET bottles and other PP.
- **Output prices.** These are estimated as average values for PET bottles and other PP outputs.
- **Number of direct jobs per 10k tonnes of PP waste in each observed phase** – measured as full time equivalent. Thus, total number of individuals engaged in PP circular economy might be much higher.

In cases where relevant data was not found, they were estimated based on combination of existing data and certain assumptions. These largely relates to revenues, costs, jobs, sorting yields and collection modes. The values in the following sections are results of estimation, they can slightly vary from exact values in reality and should be taken with caution.

More methodological details are provided in Appendix 1.

PART 2. CURRENT STATE

1. EU – legislative framework and current trends in plastic packaging

EU generates more plastic packaging waste compared to other counties in the world. Even though it improved its recycling rate, it still needs to significantly improve its waste management infrastructure. EU generates 32 kg per capita of plastic packaging waste, which is at the similar level of developed countries, but more compared to the world’s average (Eurostat data). Even though 43% of it is being recycled, a significant share is sent to be treated outside the EU (European Commission, 2019b). This fact implies that potential for plastic recycling remains largely unexploited in the EU, because it did not invest enough to build its own recycling infrastructure capable to treat waste (European Commission, 2019a).

However, China ban on plastic waste import from western countries additionally influenced EU countries to push forward legislative framework on plastic waste and circular economy. Namely, China, the leading importer of plastic waste (51% of total world plastic waste import in 2014), in January 2018 introduced ban on plastic waste from western countries (Yale Edu). EU plastic waste export to China plummeted from 1,6 million tonnes in 2016 to less than 0,15 million tonnes in 2018 (UN Comtrade data). EU countries temporarily redirected plastic waste to other eastern countries such as Malaysia, Indonesia, India, Turkey etc (ibid.). However, since some of these countries are also introducing waste import ban, EU is obliged to find more sustainable solutions.

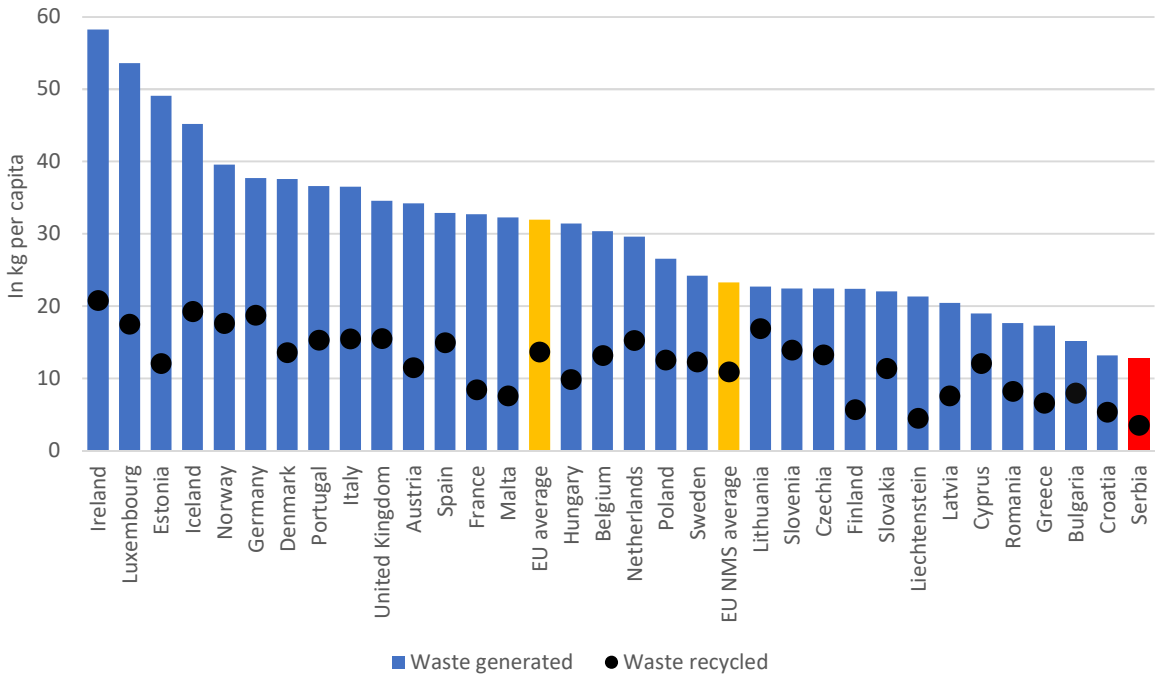
In 2018, European Commission adopted the European Strategy for Plastics in a Circular Economy, which is part of a wider plan to develop a circular economy and which identified plastics as a priority area (European Commission). The focus of the strategy is both on reduction of use of plastics, prolonged period in use based on improved materials, and on improving waste management infrastructure within EU itself. The strategy indicates that EU plastics sorting and recycling capacity should be significantly extended and modernised (European Commission, 2018). Plastics packaging is a priority in terms of design for recyclability, and the strategy underlines that by 2030 all plastics packaging placed on the EU market should be either reusable or can be cost-effectively recycled (ibid). In alignment with this, European Commission introduced new rules on the single-use plastics, which date for compliance set at 2021.

Regarding plastic packaging sector, EU has a complete legislative package in place that sets out rules on managing packaging waste. Directives 2008/98/EC on waste sets out general rules on waste management, while Directive 94/62/EC focuses on packaging and packaging waste management in particular. The latter prescribes that by the end of 2025, at least 50% by weight of plastic packaging must be recycled, and 55% by the end of 2030. Finally, Directive (EU) 2018/852 amending Directive 94/62/EC additionally imposes rules that should lead EU toward circular economy, and focuses on preventing the production of packaging waste, and promoting the reuse, recycling and other forms of recovering of packaging waste, instead of its final disposal (European Commission).

2. Plastic packaging waste quantities in Serbia

Official data indicate that Serbia placed on market and generated 13 kg of plastic packaging waste per capita, which seems to be underestimated. Comparing Serbia to comparable EU countries, there is a significant gap. Majority of EU new member states have much higher level of waste generated per capita (Graph 2). Considering differences in the level of development measured by GDP per capita, it is expected that difference is not that high. Recent Deloitte study on packaging waste in Serbia indicates that interviewees estimated actual waste generated being 30-50% higher than it is reported (Deloitte, 2018). Based on our key informants, major source of discrepancy comes from illegal dumping which slip under the radar of official statistics. Based on KOMDEL, approx. 30% of territory in Serbia is not covered by waste management infrastructure (dominantly in rural areas), and significant share of communal waste ends up in illegal dumping.

Graph 2. PP waste generation and waste recycling in EU and Serbia – official data



Source: Eurostat, SEPA

In order to assess the potential of increased PP recycling in Serbia, an essential step was to properly estimate physical quantities along the PP value chain. We focus on estimating PP waste generated and PP waste recycled. Namely, key indicators for this assessment refer to: PP placed on market, PP consumption, PP waste generated, PP collected for recycling, and PP recycled. However, considering previously mentioned assumptions, that (1) *All PP placed on market in a given year is considered waste in the same year*, and (2) *All PP collected for recycling in a given year is being recycled,* there are two main streams: PP waste generated and PP waste recycled.

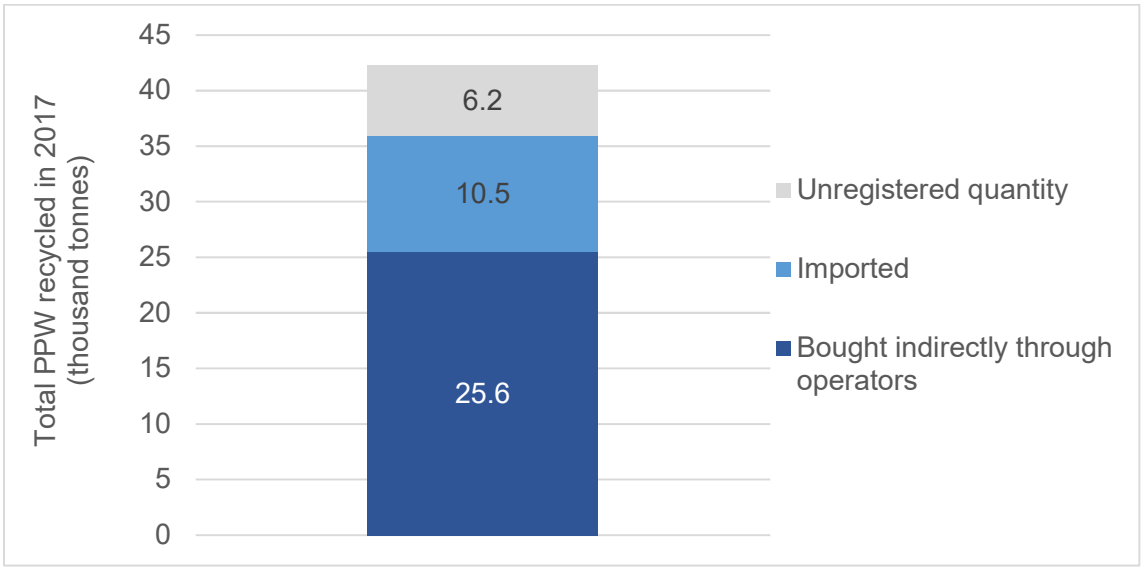
PP waste generated was estimated based on average PP waste generated per capita reported by benchmark countries. As benchmark countries, CEVES selected three EU new member states: Bulgaria, Croatia and Romania. These countries have relatively more similar level of development (compared to other more developed EU countries), as well as historical

background that could influence consumer habits. Total PP waste generated is obtained as average waste generated per capita in a given year in benchmark countries, multiplied by estimated population size in Serbia. However, since Eurostat database provides data up to 2016, PP waste generated for 2017 and 2018 is obtained based on assumed growth rate of 1.8% p.a.

Based on CEVES estimation, Serbia generates 16 kg of plastic packaging waste per capita. This estimation implies 30% higher waste generated in 2018 compared to official data (Table 2), and at the similar level that is being estimated by Deloitte in their recent report (Deloitte, 2018). Underestimated official data on PP waste generated also led to reporting an overestimated recycling rate (32%). In terms of PP waste structure, 12 kg PP waste per capita is generated by households, while 5 kg in C&I. Similarly, 7 kg of waste per capita refers to PET, and the rest to other types of PP waste. This is based on assumptions imposed in Deloitte study, while Commercial & Industrial and Households PP waste generated account for 32% and 68% respectively (Deloitte, 2018). Additionally, PET accounts for 35% of HH waste, while HH PET waste is 62% of total PET waste (Deloitte, 2017).

PP waste recycled might also be underestimated, since recyclers in Serbia recycled higher amount of PP waste in 2017 than the one reported in SEPA reports. Even though lion’s share of the difference refers to imported waste, there is an indication that overall recycling rate in Serbia might be higher. Namely, recyclers reported 42.3k tonnes of PP waste recycled in 2017 (Graph 3). The difference of 16.7k tonnes comes from two sources. In total amount recycled, 25% refers to PP waste imported. This waste is excluded from official SEPA reports, since international methodology prescribes that waste recycled is included in national reports based on the country of origin. That implies, if PP waste was generated for example in Germany and recycled in Serbia, this amount will increase German overall recycling rate. However, there is 15% of total PP waste recycled with unknown exact origin. Based on key informants, this quantity might refer to waste sold directly from collectors to recyclers, referring dominantly to informal collectors. Unlike imported quantities, the latter should have been included in Serbian rate of PP waste recycling.

Graph 3. Total PP waste recycled in Serbia by origin in 2017



Source: SEPA, CEVES calculation

However, due to the lack of reliable information, we use official data for recycled quantities. Basically, we cannot be sure about the origin of waste recycled. While it may come from individual

collectors, the difference might also refer to difference in material stock, which would imply that companies recycled waste that had been obtained in previous years. On the other hand, our assumptions based on interviews is that informal PP recycling is marginal if not even absent.

Table 2. Plastic Packaging waste streams estimation

Indicator	2013	2014	2015	2016	2017	2018
PP placed on market						
SEPA official data (k tonnes)	85.6	87.5	92.3	90.4	94.1	92.0
PP waste generated						
CEVES estimate (k tonnes)	99.1	110.9	116.0	116.4	118.0	119.6
o/w Commercial & Industrial	31.7	35.5	37.1	37.3	37.8	38.3
o/w Households	67.4	75.4	78.9	79.2	80.2	81.3
o/w PET	38.0	42.6	44.5	44.7	45.3	46.6
o/w other PP	61.1	68.3	71.5	71.7	72.7	72.9
PP recycled						
SEPA official data (k tonnes)	13.6	15.0	15.2	18.2	25.6	32.4
% of PP waste recycled*	13.7	13.5	13.1	15.6	21.7	24.9
National recycling targets** (%)			14.0	17.0	19.0	21.0

Source: SEPA, CEVES calculation based on Eurostat data
Notes:
* Share of PP waste recycled (official data) in PP waste generated (CEVES estimate)
** Decree on the introduction of Packaging Waste Reduction Plan for the 2015-2019 period (“Official Gazette RS” no. 144/2014) (PWRP)

Based on estimated quantities, Serbia recycled 25% of waste generated in 2018. Even though Serbia exceeded national recycling target of 21% in 2018, it is among countries with the lowest recycling rate in EU. As previously mentioned, 43% of EU PP waste is being recycled. Majority of EU new member states recycle even more than half of their PP waste and are close or even above EU target set by Directive 94/62/EC. Namely, countries like Bulgaria, Croatia, Czechia, Romania, Slovakia and Slovenia recycle 53%, 41%, 59%, 47%, 52% and 62% of their PP waste respectively (Eurostat data). Serbia did significantly improve its recycling rate over the last five years, but there is still much to be done in order to align with EU target requirements by 2030.

3. Plastic Packaging Value Chain in Serbia and its Key Players

In this chapter we elaborate plastic packaging value chain in Serbia, its key processes and key player, that are relevant for this impact assessment. We divide it in two key segments of PP waste management value chain:

- PP waste collection for recycling
- PP waste recycling

• PP waste collection for recycling

Serbia has low level of primary waste separation, while it heavily relies on informal sector for PP waste collection from municipal waste. The largest share of municipal waste separately collected is done manually through the process of secondary selection, and it dominantly refers to PET. Infrastructure for primary selection of municipal waste is marginal despite the effort of some PUCs. Namely, even PUCs with relatively solid success, collect less than 1,5% of municipal waste through primary selection. PP waste that *is* ultimately separated from municipal waste is done manually, sometimes by workers in PUCs on separation line machines, but dominantly by individual collectors on landfill and illegal dumping. There are estimates that approx. 90% of PPW separated comes from individual collectors, and 10% from PUCs (Deloitte, 2018). However, key informants underline that actual separate collection by PUCs staff is approx. 1% of total PP waste separated, while all the rest refers to waste that was also separated by individual collectors, and then bought from them.

Separate collection of other PP waste originating from industry has solid coverage, while segment coming from municipal waste remains largely uncovered. Waste originating from industry is separately collected at its source, and is usually managed by companies registered to collection or recyclers themselves. These companies sign contracts with firms within industry through which they take over the responsibility for collection of waste created by those companies. Sometimes they even obtain containers for separate collection, that increases material value since it remains clean. On the other hand, other PP waste from households remains landfilled. Unlike PET, this segment of PP waste neither has any system for primary collection by PUCs, nor is there an interest for individual collectors to collect it from landfills.

Key requirement in terms of circular economy is to radically improve overall primary collection (both from industry and households) and to increase the share of separate PP waste collected from municipal waste, above all because municipal waste accounts for the bulk of PP waste.

There are four key players groups within PP waste collection:

- **Public Utility Companies**.

PUCs are in charge of municipal waste collection, originating dominantly from households. However, PUCs face issues when it comes to primary selection due to the lack of financing and lack of success in these activities, and there is no strong enforcement mechanism that would ensure higher compliance with the law. The lack of financing issue refers to a wider issue of how PUCs are managed. On the one hand, PUCs still have very low prices of communal services (below economically sustainable and profitable level), while on the other, they are highly inefficient (Fiscal council, 2016).

There are 79 PUCs in charge of waste collection, and they employ 11.4 thousand workers. It is hard to distinguish how many workers is engaged in the process of PP waste collection in particular. However, based on PUCs business reports, between 20 and 35 workers is engaged

on collection of 10k of waste in general, while only marginal number on processes of primary and secondary collection. Additionally, based on our interviews, between 23% and 41% of them refer to non-core activities such as administration. For example, between 9 and 22 workers are engaged in administration per 10k waste collected as reported by PUCs.

- **Private firms registered to waste collection**

These companies are usually in charge of commercial & industrial PP waste. There are 70 firms registered for non-hazardous waste collection of any type, and they employ approx. 900 workers (NACE code 3811), while there are 121 firms in total that obtained permit for waste collection by SEPA. These companies are micro size[1], usually family companies (77% of these firms has up to 5 formally employed individuals). However, there is no data on number of companies collecting PP waste in particular. These companies work directly with companies in C&I sector and purchase waste from them. In some cases, they also can utilise *network* of informal collectors, buy waste directly from them and sell it to recyclers.

- **Individual collectors.**

Individual collectors refer to individuals (approx. 60% Roma population (GIZ, 2018)) that dominantly operate in informal market and separately collect waste from regional landfills and illegal dumps. Usually they collect PET waste, and sell it either directly to recyclers, or indirectly through firms registered to waste collection (including PUCs). Based on key informants, the network of individual collectors itself is organised in a way that there are collectors on landfills and *mediators* that gather larger waste quantities and sell it to recyclers or larger collectors. These mediators are firms that do baling of waste, and formally “legalise” waste collected by informal sector. Based on CEVES estimate, individual collectors usually obtain from 49-60% of actual selling price of product to recyclers, while the difference goes to mediators and firms registered to waste collection. The major issue with individual collectors is the fact that vast majority of them is not registered in the waste management system. Usually, there is certain number of them that cooperate directly to recyclers, while having much larger network of collectors working with them. Since the network is organised, operational costs are estimated to be up to 9% of total revenues (selling price multiplied by waste collected quantity).

There is no reliable data on how many individual collectors are operating in Serbia. There is rough assessment that approx. 35-50 thousand individuals are engaged in the process of separate collection of different types of waste (PP, EEE, metal, paper etc.) (GIZ, 2018). These individuals only collect several hours a day, which cannot be considered as full-time engagement in PP collection. Based on an assumption that one collector can collect up to 750 bottles a day, **we obtain that currently approx. 1,150 FTE jobs is engaged in collection of 12k tonnes of PET waste**. Taking into account partial engagement of PP waste during a day, we estimate that **somewhat between 2 and 3.5 thousand informal collectors is currently engaged on separate collection of PP waste.**

- **“Operators”.**

Operators are companies that are in charge of packaging waste management, based on the Law of packaging and packaging waste. They collect fee from producers (the polluter) and use financial flows to improve system of primary selection. They also pay certain compensation to collectors for waste they collected. In terms of physical flows, they act as intermediaries between waste collectors and recyclers. In 2018, there were 6 registered operators in charge of managing waste for 1.9 thousand firms (SEPA, 2018).

[1] Employ less than 10 workers.

Finally, there are two important aspect of the process of waste collection for recycling:

1) Quantity of PP waste separately collected
2) Quality of PP waste separately collected

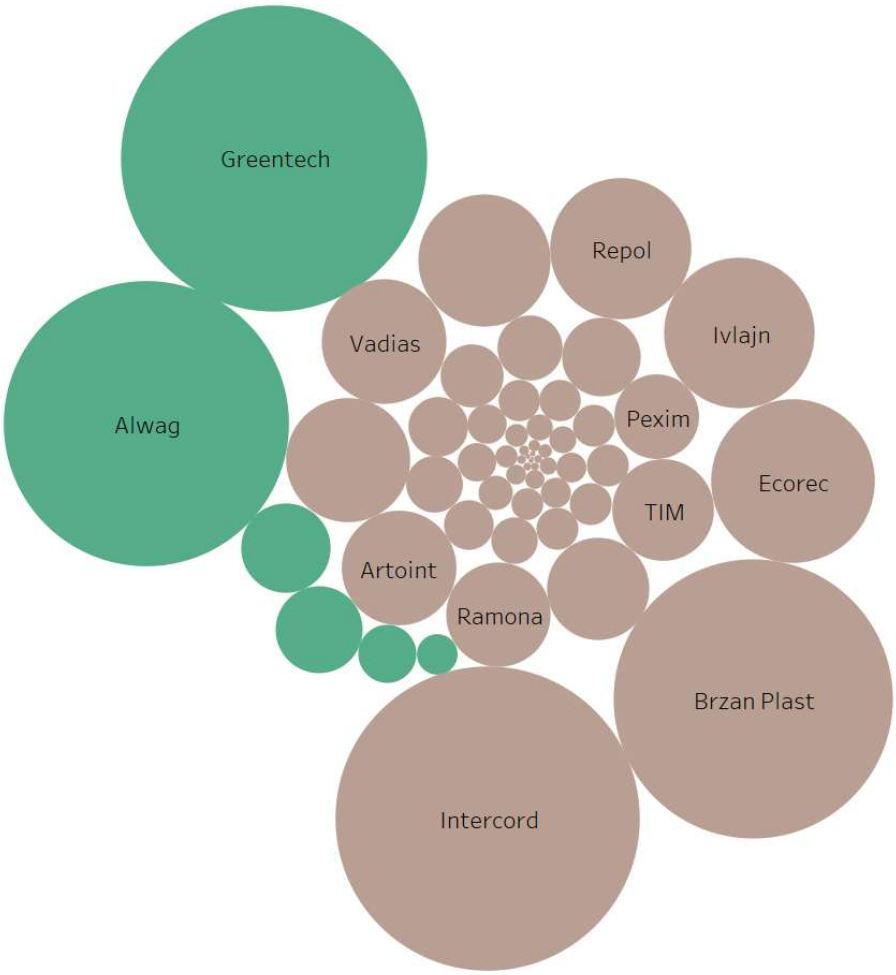
While quantity is essential for the increase of PP recycling, the quality of waste selected significantly determines the sustainability and profitability of recycling business. While some companies rely in their business only on “clean waste”, the vast majority of companies interviewed noted that there was an issue of low quality of the waste they buy. They underline that share of recyclables in waste obtained from landfills can vary from 65% to 95%, depending on the amount of dirt. For example, PET collected from landfill has significantly reduced material value. This can be solved by better organised collection from Commerce & Industry, as well as radically improved primary selection from municipal waste. There are examples how recyclers provided specific canisters for selection and disposal of waste, hermetically sealed, which have no contact with weather conditions.

- ## PP waste recycling

Recycling sector is the heart of PP waste management system. Even though this sector is considered to be competitive[2] (no market concentration in terms of quantities recycled), there are few market leaders in both segments of PP. In 2017, there were 57 active recyclers that reported that they recycled at least a kilo of PP waste. Out of those, 4 largest recyclers accounted for even 61% of total PP waste recycled (Graph 4). 10 major recyclers recycled more than 1000 t, while 23 recycled less than 200 t in 2017. Still, PET recycling in Serbia is highly concentrated. There are two large PET recyclers (“Greentech” and “Alwag”) which account for more than 95% of all PET recycling. There are also several smaller recyclers of PET. On the other hand, recycling of other PP types is also concentrated, but there is much larger number of firms included. There are several leaders within this group: “Intercord”, Brzan Plast”, “Ecorec”, “Ivlajn”, “Repol”, “RKS kompoziti” etc.

[2] Based on Herfindahl-Hirschman Index (HHI), PP recycling sector is considered competitive, without sector concentration. Based on market share of companies, measured by quantities of waste recycled in 2017, HHI is 997. All sectors with HHI below 1500, are considered competitive, while above 1500 are considered moderate or highly competitive.

Graph 4. Active recyclers of PPW in 2017.



Source: SEPA
Note: Size of bubble refers to tonnes of PPW recycled in 2017. Colour refers to type of plastic that is dominantly recycled (*green* - PET, *grey* - other PP)

Recycling sector is strongly dependent on the waste collection in Serbia. Recyclers receive material input from different sources, but on average, 60% of purchases refer to PUCs and private companies registered to collection. While PUCs mostly provide PET, private companies cover industrial waste. 25% of total input purchased refers to imports. However, recyclers also receive inputs directly from individual collectors. These purchases are also registered by recyclers, since they are obliged to have certificate on origin of waste. However, these quantities might not be covered by Operators that are obliged to report on waste management.

Based on CEVES estimation, 18 workers are engaged per tonne of waste recycled on average. Of course, this vary for PET and other PP recycler, and can also vary based on the technological capacities and the labour intensity of companies. For example, as previously mentioned, some recyclers need to engage significant share of workforce in selection process prior to recycling. One segment of it refers to preparation processes (washing of waste and rough removal of unwanted waste categories). However, the largest share refers to a *fine* selection of waste according to types. This process cannot be easily transferred to primary selection process and collection sector, since it requires specific expertise in material types. Namely, companies

underlined that they need several years to train employees to distinguish different plastic within same product type, and this cannot be done even by machines.

By recycling 26,200 tonnes PP waste, recyclers created 6 million of GVA in 2018. Large share of it accounts for EBITDA (56%), while 44% refers to gross wages. According to CEVES' estimate of recycling sector consolidated income statement in 2018, material costs account for 52% of total operating cost in recycling business (Table 3), out of which between 88% and 95% refers to input material purchased (PP waste). Average net salary in sector is close to minimal wage and it ranges between 224 EUR to 374 EUR. Sector receives marginal amount of state subsidies, which account for 0.5% of total sectors' revenues.

Table 3. Calculation of Gross Value Added created by recycling sector in 2018 (mil EUR)

Indicator		Gross Value Added	
		Value	%
A	**Total revenues**	**18.1**	
B	**Total operational costs (1+2+3+4+5)**	**15.7**	100.0
1	o/w Material costs	8.1	51.7
2	o/w Gross wages costs	2.6	16.6
3	o/w Fuel costs	1.8	11.4
4	o/w Amortisation costs	1.0	6.6
5	o/w Other costs	2.2	13.7
C	**Operative result (A - B)**	**2.4**	
D	**EBITDA (C + 4)**	**3.4**	
E	**Gross Value Added (D + 2)**	**6.0**	

Source: CEVES estimate

Direct output of recycling is recycling input (regranulate) that is used as an input in production of plastic products. **Certain number of recyclers in Serbia, apart from recycling, uses their recycling output for production of final products.** Examples are “BrzanPlast” that produces plastic foils for construction industry, “Ramona” that produces plastic bags etc. PET recyclers on other hand do not produce final product, but export recycling output to EU countries.

PART 3. CIRCULAR ECONOMY IMPACT ASSESSMENT

This assessment estimates how many jobs and what gross value added would be created in two opposing scenarios: if no additional effort is put in improving current waste management system (Business As Usual scenario) or if circular economy principles are implemented and targets defined by the Strategy achieved (Target scenario). Essential for Target scenario is to improve current waste management system, so that we collect and recycle higher quantities of good quality PPW.

As previously mentioned, there are two key aspects of waste management improvement:

- **Efficiency**: Quantity of waste being collected and recycled
- **Effectiveness**: Quality of the waste collected.

While increased quantities of PP waste collected and recycled is key to reaching the national and EU recycling targets, quality of waste collected is essential to the entire value chain sustainability (*see* section 3). Taking this into account, we propose two scenarios, and 1+3 sub-scenarios that imply the following:

Business as Usual (BAU) scenario implies none of improvements in current system. This means that by 2030 we would keep current pace of waste collection and treatment, remaining at recycling rate of 22%. Waste collection would still heavily rely on the secondary selection and informal collectors, while recyclers would still face costs due to the low quality of obtained PP waste.

Target scenario implies increased PP waste recycling and reaching the recycling rate of 55%. However, there are three sub-scenarios that define *how* would be reached this recycling rate – by building the system of primary collection or keep on relying on secondary selection by informal collectors. Thus, there are three **target sub-scenarios**:

- Target sub-scenario 1 (**T1**): **No improvement in the system of primary selection**
- Target sub-scenario 2 (**T2**): **Improved system of primary selection**
- Target sub-scenario 3 (**T3**): **Significantly improved system of primary selection**

Each of target sub-scenarios refer to reaching separate waste collection and recycling rates of 55% by 2030, while only depending on the structure of separate collection process. Regarding PET, T1 implies relying on current waste collection structure -- 99% PPW being collected by informal collectors. T2 and T3 on other hand, imply different level of inclusion of informal collectors into formal system and different level of primary selection system efficiency. Both rely on public raised awareness of separate collection, which directly reduces the need for individual collectors on landfills. On the other hand, regarding other PP, since industrial waste is already covered by private firms registered for collection, T2 and T3 scenario to be reached would require higher involvement of PUCs in separate collection from municipal waste (and thus higher share in waste collected). Detailed assumptions on these sub-scenarios are given in the following table.

Table 4. Structure of waste separate collection - different scenarios

Scenarios	BAU	Target		
		T1	T2	T3
PET waste collected	100%	100%	100%	100%
Public Utility Companies	1%	1%	45%	60%
Individual collectors	99%	99%	55%	40%
Other PP waste collected	100%	100%	100%	100%
Public Utility Companies	8%	8%	25%	37%
Private firms registered for collection	74%	74%	57%	45%
Recyclers themselves	15%	15%	15%	15%
Individual collectors	3%	3%	3%	3%

BAU scenario and T3 scenarios are lower and upper boundary of future outcomes by 2030. Depending on the level of circular economy implementation, actual impact could take values between lower and upper boundaries.

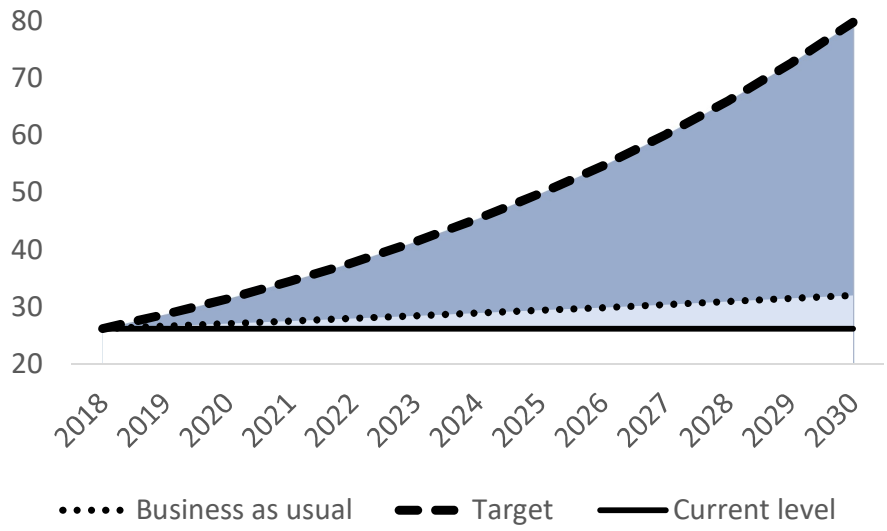
Target scenario to happen would require taking care of the following two aspects: (1) establishing a sustainable and efficient system, but also (2) integrating individual collectors into the formal system. The first aspect refers to building a separate waste collection infrastructure across country, raising awareness among citizens on separate collection, improving the system efficiency (tackling both public and private collectors), implementing enforcement mechanisms that would prevent informal collection activities etc. The second aspect would translate informal collectors into *green jobs*[3]. That would imply diverting informal collectors from landfills to primary collection activities within registered companies (for more, *see* section 5).

[3] ILO’s *green jobs* definition: “Green jobs are decent jobs that produce goods, provide services or make production processes more energy and resource efficient and less polluting.” (ILO, 2018)

1. Impact on collected and recycled quantities

Reaching national and EU recycling target implies significant increase in separate waste collection. Even though recyclers have higher recycling capacities, they are sometimes obliged to rely on imports, due to insufficient quality and quantity of PPW separately collected in Serbia (Graph 3). Current collections system brought to recycling of only 26.2k tonnes in 2018 -- 22% of waste generated. Staying at business as usual, would increase quantity of waste recycled only by 2% annually. On the contrary, in order to reach target of 55% PP waste recycled by 2030, it is essential to implement a system that could increase separate collection by a growth rate of even 10% annually (Graph 5). This would bring required 53k tonnes of waste collected and recycled.

Graph 5. BAU vs Target: Waste recycled quantities (in k tonnes)



Source: CEVES estimation

Depending on scenario, separate collection of 80k tonnes of PP waste by 2030 could be reached either through improved separate collection system, or it would alternatively imply radically higher increase of individual collectors on landfills and dumps. However, **one should bear in mind that neither of these scenarios is an easy task**. Radical increase of individual collectors involved is neither a systematic solution, nor it is manageable by relevant institutions (*see* next section). On the other hand, sub-scenario T3, significantly improved system of primary selection, would require significant investment in containers for separate collection infrastructure across country, and strong commitment of public utility companies on making this system efficient. That would include not only continuous raising awareness campaigns, but also mechanisms that would prevent irregularities, such as taking from containers for separation[4], informal waste collection from companies etc.

In reality, it is expected that a variation of these four scenarios would occur. The result depends on system efficiency in place, but also on citizens awareness and willingness to select

[4] Particular issue refers to the lack of legislation that would define waste ownership. Currently, for example, waste collected through containers is not considered to be owned by PUCs, so legally cannot be considered as a theft.

waste. For example, if a system of primary selection is introduced, but separate collection rates remain at a lower level than 45% or 60% of planned, that would still mean higher involvement of individual collectors.

2. Impact on job creation

Strategy implementation and increased recycling of plastic packaging would have positive effects on job creation, but for sustainable solution Serbia needs to radically improve its collection system. While increased quantities recycled would bring approx. additional 950 new jobs in recycling sector, collection strongly depends on the collection system in place. If collection is to be increased without improvements in primary collection system, an excessive reliance is to be put on informal sector. Workforce needed for each scenario is presented in Table 5.

Table 5. Impact on job creation by 2030

Indicators	Baseline 2018	Value in 2030				Change 2030 vs. 2018			
		BAU	TARGET			BAU	Target		
			T1	T2	T3		T1	T2	T3
PPW recycled (k tonnes)	26	32	80	80	80	6	54	54	54
Total jobs	**1,698**	**2,075**	**5,886**	**4,221**	**3,667**	**377**	**4,188**	**2,523**	**1,969**
Total in collection, sorting and transport	1,210	1,478	4,450	2,785	2,231	268	3,240	1,575	1,021
o/w formal jobs	93	114	286	415	473	21	193	322	380
o/w individual collectors	1,117	1,365	4,164	2,370	1,758	248	3,048	1,253	641
Total in recycling	488	597	1,436	1,436	1,436	108	948	948	948

Source: CEVES estimate
Note: All numbers refer to full time equivalent (FTE)

Sub-scenario T3. Significantly improved system for primary selection

Reaching target by building an efficient system of primary collection could create additional 1.3 thousand jobs in collection and recycling, but would also imply integrating additional 1-2.5 thousand individual collectors into the formal collection system. This scenario provides optimal results both in terms of quality of waste and quality of work. It implies the highest share of PPW recyclable materials is separated at source, waste is cleaner and has higher share of recyclables. The T3 sub-scenario would create the conditions for the transformation of informal and precarious engagements into green jobs, provided that the transformation involves decent working conditions – registered jobs, with social security and good occupational safety.

Diverting informal collectors from landfill, and relying on primary collection system requires systematic changes, and could be probably accomplished gradually over the long-term period. Particularly sensitive question is diverting individual collectors from landfills, since most often they are inclined to preserve that kind of work. In order to change that, the reform of social security system needs to be introduced. That will provide that informal collectors gain motivation to change current work for formal employment.

Sub-scenario T2. Improved system for primary selection

A moderate, sub-scenario T2 implies improvement in system of primary collection, but sill significantly relies on individual collectors. Unlike sub-scenario T3, T2 would require additional 1,3 thousand jobs in collection and recycling and 1,3 thousand additional FTE individual collectors. Since this refers to FTE employment, this still implies inclusion of great number of individual collectors -- from 2 to 3 thousand individual collectors actually engaged.

As it can be observed, **efficiency in collection system represent a combination of formal jobs and individual collectors’ inclusion into the formal system**. As relevant experts underline, the more system relies on individual collectors, the harder and less probable is their inclusion into formal system.

Sub-scenario T1. No improvement in the system of primary selection

Reaching recycling target without building an efficient system of primary collection seems difficult to obtain. As showed in T1 sub-scenario (Table 5), reaching additional 54k of PP waste collected and recycled by relying on current collectors’ structure, would imply approx. additional 3k FTE individual collectors. In reality, if we assume that there is unlimited supply of labour among individual collectors, this would assume between additional 6k and 9k new individual collectors engaged in secondary selection on landfills and dumps. However, we believe that this is a rather a quantitative illustration, then it could become an actual scenario in future. Namely, this sub-scenario would have several issues:

- **Individual collectors in Serbia refer to precarious work**. Such work does not provide basic conditions for decent work which includes a fair income, security in the workplace and social protection for families, better prospects for personal development and social integration etc. (ILO).
- **Government neither can rely its governance on informal market nor would it have formal mechanisms to cope with** such a radical increase of individual collectors in informal sectors.
- **It is hard to expect that informal waste collection market itself would bring such a radical increase of collectors, since there are barriers to enter**. Based on key informants, this market seems to be informally very organised, but also hierarchical. Additionally, they noted that private and public landfills usually allow only certain number of collectors (usually Roma) to enter and separate PPW. Finally, if there were no barriers to enter, there would be no obstacle to have higher number of collectors and higher level of waste collected even today.
- Last but not least, **recyclers are more inclined to buy “cleaner” waste**. Waste collected from landfill and dumps has the highest share of dirt, and thus the lowest recyclable value per tonne for recyclers. Thus, as the system evolves, recyclers might become reluctant to buy less clean waste in future.

Business as Usual Scenario.

Finally, **the worst-case scenario is remaining at business as usual level**, that would not bring improvement neither in quantities recycled nor in building a waste management system. If this is to happen, Serbia will marginally increase recycling quantities. This would create only 108 jobs in recycling sectors, and some 268 FTE in collection, out of which even 248 would refer to FTE informal collectors on landfills (Table 5).

3. Impact on Gross Value-Added creation

Introduction of circular economy could contribute to a significant growth of gross value added, and generate up to 272 million EUR in observed period. This is 144 million EUR more compared to BAU scenario where none of improvements is introduced (Table 6). As shown by different target sub-scenarios, depending on the circular economy implementation, actual GVA generated would take some value between these two boundaries.

Table 6. Impact on GVA creation by 2030

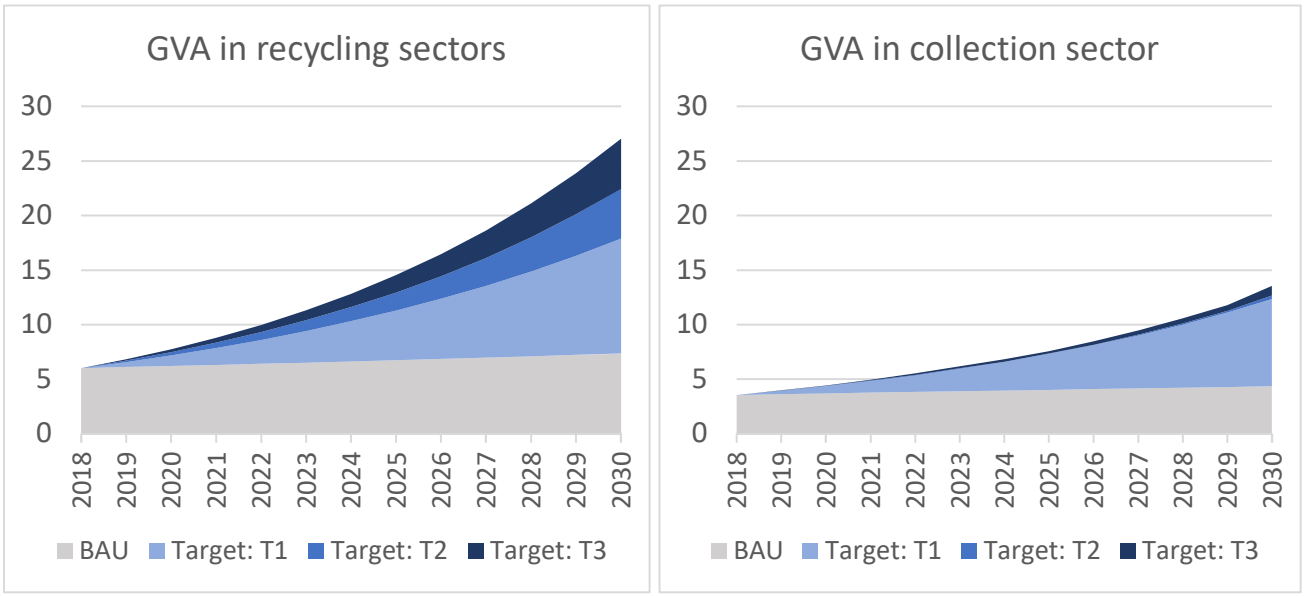
Indicators	Baseline 2018	Value in 2030				Cumulative change 2019-2030 vs. Baseline*			
		BAU	TARGET			BAU	TARGET		
			T1	T2	T3		T1	T2	T3
PPW recycled (k tonnes)	26.2	32.0	79.8	79.8	79.8	5.8	53.6	53.6	53.6
Total GVA (mil EUR)	**9.5**	**11.6**	**30.1**	**35.4**	**40.7**	**13.5**	**109.8**	**133.6**	**158.3**
Total in collection, sorting and transport	3.5	4.3	12.2	12.9	13.6	5.2	45.7	47.8	51.2
o/w Public Utility Companies	0.2	0.2	0.4	6.0	8.4	0.2	1.5	26.6	36.3
o/w Private firms registered to collection	0.6	0.7	1.5	1.1	0.9	0.8	5.0	3.9	2.8
o/w Individual collectors	2.7	3.4	10.3	5.8	4.3	4.2	39.2	17.4	12.2
Total in recycling	6.0	7.3	17.9	22.5	27.0	8.3	64.1	85.8	107.0

Source: CEVES estimate

Note: * Extrapolated values of baseline 2018 on the entire period between 2019-2030

Recycling sector would particularly benefit from significantly improved waste management system, since the quality of waste directly influence their profitability. If an efficient system of primary collection of waste was in place, recyclability of material inputs (PPW obtained from collectors) could rise on average from 80% to 95%. This would directly reduce costs and increase profitability of recycling business. In T3 sub-scenario, recyclers could reach up to annual 27 million EUR of GVA in 2030, which is even 9 million EUR more compared to T1 scenario (Graph 6). On the other hand, T1 scenario would create 11 million more GVA compared to BAU in 2030, which would be based only on increased quantity recycled and same material recyclability.

Graph 6. GVA created in recycling and collection sectors in different scenarios (mil EUR)

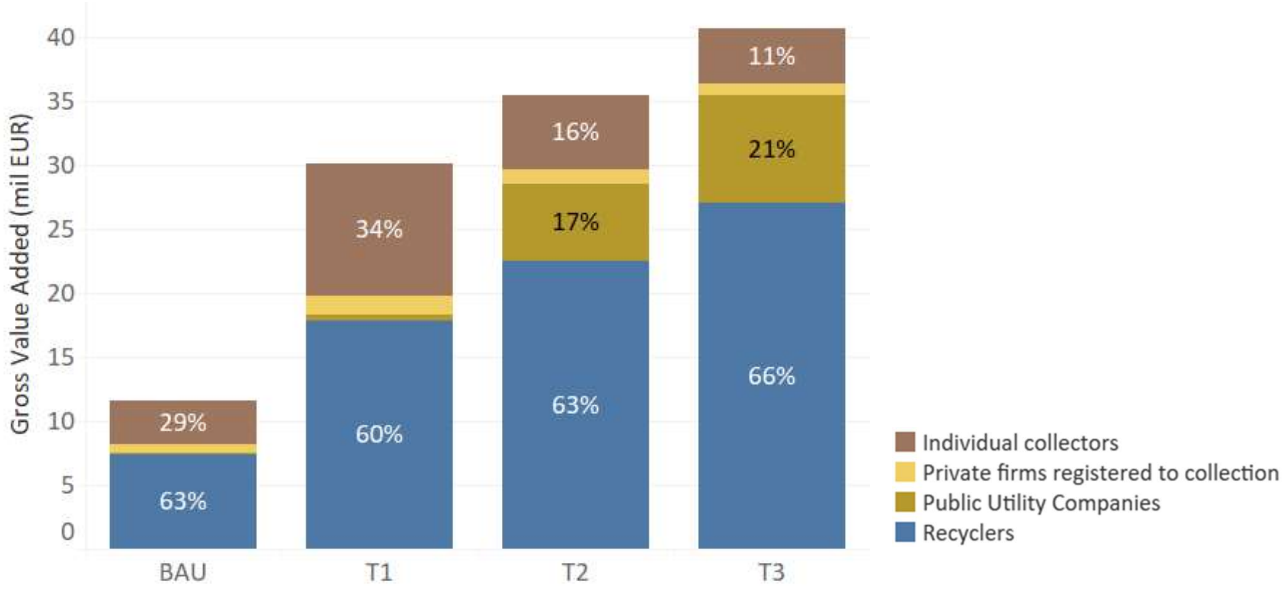


Source: CEVES estimate

On the other hand, collection sector would create similar level of GVA in each target sub-scenarios, but the difference refers to the allocation among key players. All three sub-scenarios would reach approx. between 12 and 14 million EUR in 2030 (Graph 7), with only

slightly higher level in T3. The difference based on the allocation would originate in restructuring of collection system by the end of 2030. In T3 compared to T1, value would be transferred from individual collectors to PUCs. The model assumes that private companies registered to collection would reach collection level of PP waste generated in C&I and remain there.

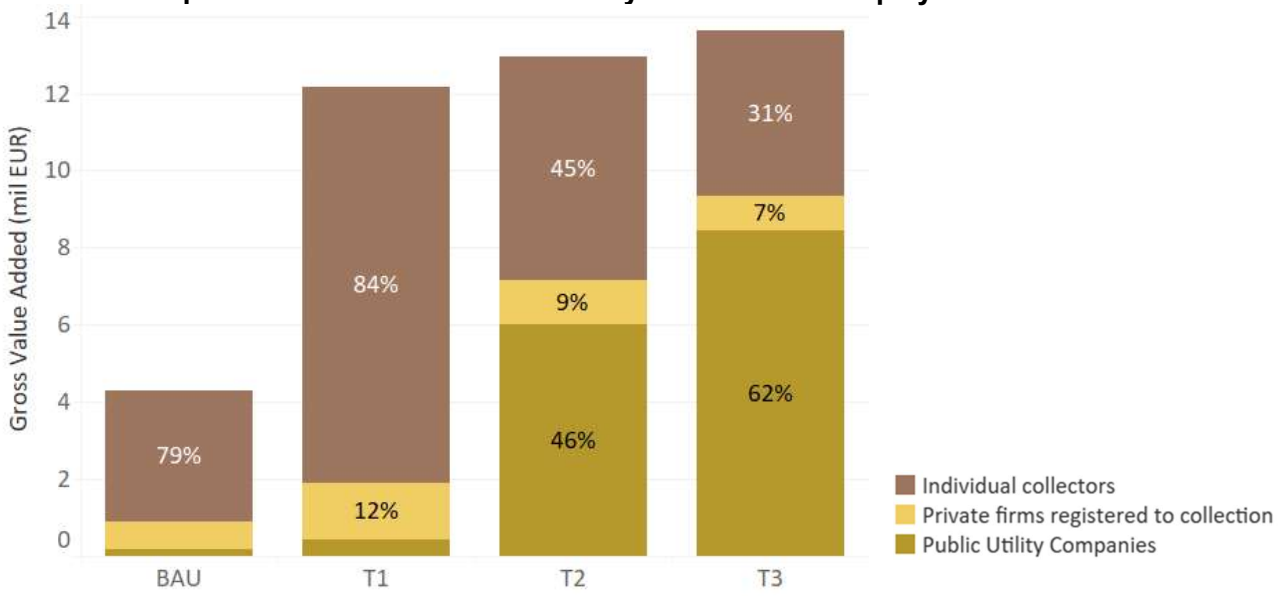
Graph 7. Structure of GVA created by different players in PPW value chain in 2030



Source: CEVES estimate

It needs to be stressed that current GVA coming from individual collectors dominantly refers to informal economy. Thus, reaching target recycling rate without improvements in formal collection system would imply that 84% of GVA created in collection would be generated in informal sector (Graph 8). Improvements in waste management system would not only require higher engagement of Public Utility Companies (62% of GVA in scenario T3), but also translating remaining 31% of value created from informal to formal economy. These individual collectors could be part of either public or private sectors, and thus would be allocated to one of these two major formal players in total.

Graph 8. Structure of GVA created by waste collection players in 2030



Source: CEVES estimate

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APPENDIX 1. METHODOLOGY DETAILS

- **DATA**

This methodology is based on official data sources and data collection from:

Official data sources:

- SEPA annual report on waste flows. These reports are used for waste recycled quantities
- SEPA database. This database is used for firm-level data on waste quantities in collection and transport.
- Eurostat database. This database is used for benchmark data on waste generated and waste recycled of EU countries.
- UN Comtrade database. This database is used for export and import data for Serbia and other benchmark countries.
- Official financial statements (Balance Sheets and Income Statements). These reports are used for estimating revenues and different cost categories per PP waste collected and/or recycled.
- Official business reports of PUCs. These reports are used to obtain more detailed data on employment structure, waste collection structure, buying and selling price of separately selected waste.
- Different relevant studies. CEVES referenced to other relevant studies that obtained estimations necessary for this assessment.

Data collection:

- Face to face interviews with recyclers. CEVES interviewed 5 recyclers this way.
- Telephone interview with recyclers CEVES interviewed 10 recyclers this way. Both face to face and telephone interviews cover 68% of recycling sector in Serbia.
- Face to face interviews with PUCs. CEVES interviewed 4 PUCs this way.
- Online questionnaires with PUCs. CEVES interviewed 9 PUCs this way.
- Telephone interview with Private firms registered to waste collection. CEVES interviewed 2 firms this way.
- Face to face interviews with operators. CEVES interviewed 1 operator this way.
- Interviews with key informants that are considered to be expert in this field.

- **ASSUMPTIONS**

This methodology is based on the following assumptions:

- All PP placed on market in a given year is considered waste in the same year. This implies that within a year, PP placed on market equals PP consumed, which ultimately equals PP waste generated.

- All PP collected for recycling in a given year is being recycled. This implies that waste separately sorted is being recycled in the same year. PP waste collected within municipal waste and was not separated is not relevant for this methodology.
- Households PP waste generated account for 32% and 68% respectively (Deloitte, 2018).
- PET accounts for 35% of HH waste, while HH PET waste is 62% of total PET waste (Deloitte, 2017).
- Waste generated annual growth rate from 2018 to 2030 is assumed to be constant and equals 1,9%. It is calculated as an average annual growth rate of PP waste generated in EU28 countries from 2013 to 2016.
- Recycling rate of 55% in 2030 for total PP is assumed to be reached by recycling 70% of PET and 45% of other PP. This is based on the assumption that PET separate collection will grow faster compared to other PP.
- Structure of PET waste collection in 2018: PUCs 1%, individual collectors 99%.
- Structure of Other waste collection in 2018: Private firms registered to waste collection 70%, Recyclers 15%, PUCs 10%, Individual collectors 5%
- Change in waste collection structure from 2019 to 2030 is provided in Table 4.
- Recycling yield (recycling output weight divided by recycling input used) in 2018 is assumed to be 83%
- Recycling yield in target sub-scenario is assumed to reach: 83% in T1, 90% in T2 and 97% in T3.
- Adoption of target scenarios are assumed to grow gradually over the 2019-2030 period and are calculated as monotonic increasing linear function starting from baseline in 2018. This includes the adoption rates for the following indicators: recycling rate, collection structure, recycling yield.
- Average recycling input and output prices are assumed to be constant over the period.
- Average material, wages, fuel, amortisation and other costs are assumed to be constant over the period.

- **ESTIMATION OF JOBS CREATED**

Estimation of jobs created is conducted separately for collection sector and for recycling sector. Within each sector, separate estimation was conducted for PET and for OTHER PP waste. Assumptions regarding shares of waste collected by product and by collector are given in Part 3.

Waste collection sector

Waste is being collected by two wider and three more specific groups of collectors. There are *formal collectors* refer to Public Utility Companies and Private companies registered to waste collection, and *informal collectors.* PET waste is assumed to be collected by PUC and informal collectors, while OTHER PP waste is assumed to be collected by all groups of collectors. Regarding OTHER PP waste, a share of it is collected by recyclers directly. However, those jobs are included in formal jobs in recycling sector, as an integral part of their business.

We separately calculate formal and informal jobs:

Formal Jobs in collection sector were estimated, as outlines the following formula:

$$FJC_n = WC_n * w_{c1\ p1\ n} * (C_{c1\ adm} + C_{c1\ c\&t} + C_{c1\ sr}) + WC_n * w_{c1p2\ n} * (C_{c1\ adm} + C_{c1\ c\&t} + C_{c1\ sr}) + WC_n * w_{c2\ p2\ n} * C_{c2\ t}$$

Where:

Symbol	Meaning	Estimation method
FJC_n	Formal jobs in Collection in year n	Sum of all components in equation
WC_n	Waste collected for recycling in year n	Benchmark method (*see.* P 13)
$w_{c1\ p1\ n}$	Share of PET waste collected by PUCs in year n	Interviews with key informants
$C_{c1\ adm}$	Estimated number of workers in PUCs in administration per 10k tonnes of waste collected for recycling	Financial statements and interviews
$C_{c1\ C\&t}$	Estimated number of workers in PUCs in collection and transport per 10k of waste collected for recycling	Financial statements and interviews
$C_{c1\ sr}$	Estimated number of workers in PUCs in primary and secondary sorting per 10k tonnes of waste collected for recycling	Financial statements and interviews
$w_{c1\ p2\ n}$	Share of OTHER PP waste collected by PUCs in year n	Interviews with key informants
$w_{c2\ p2\ n}$	Share of OTHER PP waste collected by Private companies registered for waste collection in year n	Interviews with key informants
$C_{c2\ t}$	Total estimated number of workers in Private firms registered to collection per 10k tonnes of waste collected for recycling	Financial statements and interviews

Informal Jobs (FTE) in collection sector were estimated, as outlines the following formula:

$$IJC_n = WC_n * w_{c3\ p1\ n} * C_{c3\ p1}$$

Where:

Symbol	Meaning	Estimation method
IJC_n	Formal jobs in Collection in year n	Sum of all components in equation
WC_n	Waste collected for recycling in year n	Benchmark method (*see* p. 13)
$w_{c3\ p1\ n}$	Share of PET waste collected by Individual collectors in year n	Interviews with key informants
$C_{c3\ p1}$	Estimated FTE number of Individual collectors in charge of collection of 10k tonnes of waste for recycling	Interviews with key informants (*see* p. 18)

Waste recycling sector

Firms are divided to those recycling PET and those recycling OTHER PP. We assume that there are no informal jobs created in recycling sectors.

Jobs in recycling sector were estimated as product of quantities of collected waste and workers required to process these quantities, as outline the following formula:

$$JR_n = WR_n * w_{p1\,n} * \left(C_{r1p1\,adm} + C_{r1p1\,rec} + C_{r1p1\,s\&t}\right) + WR_n * w_{p2\,n} * \left(C_{r1p2\,adm} + C_{r1p2\,rec} + C_{r1p2\,s\&t}\right)$$

Where:

Symbol	Meaning	Estimation method
JR_n	Jobs in Recycling in year n	Sum of all components in equation
WR_n	Waste recycled in year n	Benchmark method (*see.* P 13)
$w_{p1\,n}$	Share of PET waste recycled in year n	Interviews with key informants
$C_{r\,p1\,adm}$	Estimated number of workers in PET recycling companies in administration per 10k tonnes of waste recycled	Financial statements and interviews
$C_{r\,p1\,rec}$	Estimated number of workers in PET recycling companies in recycling per 10k tonnes of waste recycled	Financial statements and interviews
$C_{r\,p1\,s\&t}$	Estimated number of workers in PET recycling companies in sorting & transport per 10k tonnes of waste recycled	Financial statements and interviews
$w_{p2\,n}$	Share of OTHER PP waste recycled in year n	Interviews with key informants
$C_{r\,p2\,adm}$	Estimated number of workers in OTHER PP recycling companies in administration per 10k tonnes of waste recycled	Financial statements and interviews
$C_{r\,p2\,rec}$	Estimated number of workers in OTHER PP recycling companies in recycling per 10k tonnes of waste recycled	Financial statements and interviews
$C_{r\,p2\,s\&t}$	Estimated number of workers in OTHER PP recycling companies in sorting & transport per 10k tonnes of waste recycled	Financial statements and interviews

- **ESTIMATION OF GVA CREATED**

GVA is basically calculated based on the formula:

$$GVA = Operating\ result + Cost\ of\ amortisation + Gross\ costs\ of\ wages$$
$$= EBITDA + Gross\ costs\ of\ wages$$

More detailed formula required for assessment are derived from the previous one. In the following segments, we provide separate formula for GVA estimation in collection and recycling sector.

Each sector is additionally fragmented based on type of product (PET and Other PP) and key players involved within each sector.

Waste collection sector

GVA in collection sector was estimated as sum of EBITDA and wages in formal and informal collection sector.

$$GVAC_n = GVAFC_n + GVIFC_n = (WR_n * w_{c1\,p1\,n} * \left(P_{c1\,p1} - CS_{m\,c1\,p1} - CS_{w\,c1\,p1} - CS_{am\,c1\,p1} - CS_{f\,c1\,p1} - CS_{ot\,c1\,p1}\right) + WR_n * w_{c1\,p1\,n} * CS_{am\,c1\,p1} + WR_n * w_{c1\,p1\,n} * CS_{w\,c1\,p1}) + (WR_n * w_{c3\,p1\,n} * \left(P_{c3\,p1} - P_{c3\,p1} * 0{,}08\right)) + (WR_n * w_{c1\,p2\,n} * \left(P_{c1\,p2} - CS_{m\,c1\,p2} - CS_{w\,c1\,p2} - CS_{am\,c1\,p2} - CS_{f\,c1\,p2} - CS_{ot\,c1\,p2}\right) + WR_n * w_{c1\,p2\,n} * CS_{am\,c1\,p2} + WR_n * w_{c1\,p2\,n} * CS_{w\,c1\,p2}) + (WR_n * w_{c2\,p2\,n} * \left(P_{c2\,p2} * EM_{c2\,p2}\right) + WR_n * w_{c2\,p2\,n} * CS_{c2\,p2}) + (WR_n * w_{c3\,p2\,n} * \left(P_{c3\,p2} - P_{c3\,p2} * 0{,}08\right))$$

Where:

Symbol	Meaning	Estimation method
$GVAC_n$	GVA in Collection in year n	Sum of all components in equation
$GVAFC_n$	GVA in formal collection sector in year n	Sum of all components in equation
$GVAIC_n$	GVA in informal collection sector in year n	Sum of all components in equation
P_p	Estimated business revenues per 10k tonnes of product *p* waste recycled	Financial statements and interviews
$CS_{m\,p}$	Estimated material costs per 10k tonnes of product *p* waste recycled	Financial statements and interviews
$CSw_{\,p}$	Estimated gross wages costs per 10k tonnes of product *p* waste recycled	Financial statements and interviews
$CS_{am\,p}$	Estimated amortisation costs per 10k tonnes of product *p* waste recycled	Interviews with key informants
$CS_{f\,p}$	Estimated fuel costs per 10k tonnes of product *p* waste recycled	Financial statements and interviews
$CS_{ot\,p1}$	Estimated other costs per 10k tonnes of product *p* waste recycled	Financial statements and interviews
EM	EBITDA margin	Financial statements and interviews
C1	PUC	
C2	Private firms registered to waste collection	
C3	Informal Collectors	
P1	PET	
P2	OTHER PP	

Waste recycling sector

GVA in recycling sector was estimated as sum of EBITDA and wages in recycling sector, as specifies the following formula:

$$GVAR_n = (WR_n * w_{p1\,n} * w_{p1\,or} * P_{p1} - (WR_n * w_{p1\,n}(CS_{m\,p1} + CS_{w\,p1} + CS_{am\,p1} + CS_{f\,p1} + CS_{ot\,p1}) + WR_n * w_{p1\,n} * CS_{am\,p1} + WR_n * w_{p1\,n} * CS_{w\,p1}) + (WR_n * w_{p2\,n} * w_{p2\,or} * P_{p2} - WR_n * w_{p2\,n} * (CS_{m\,p2} + CS_{w\,p2} + CS_{am\,p2} + CS_{f\,p2} + CS_{ot\,p2}) + WR_n * w_{p2\,n} * CS_{am\,p2} + WR_n * w_{p2\,n} * S_{w\,p2})$$

Where:

Symbol	Meaning	Estimation method
$GVAR_n$	GVA in Recycling in year n	Sum of all components in equation
P_p	Estimated business revenues per 10k tonnes of product *p* waste recycled	Financial statements and interviews
$CS_{m\,p}$	Estimated material costs per 10k tonnes of product *p* waste recycled	Financial statements and interviews
$CSw_{\,p}$	Estimated gross wages costs per 10k tonnes of product *p* waste recycled	Financial statements and interviews
$CS_{am\,p}$	Estimated amortisation costs per 10k tonnse of product *p* waste recycled	Interviews with key informants
$CS_{f\,p}$	Estimated fuel costs per 10k tonnes of product *p* waste recycled	Financial statements and interviews
$CS_{ot\,p1}$	Estimated other costs per 10k tonnes of product *p* waste recycled	Financial statements and interviews
$W_{p\,or}$	Estimated recycling yield for product p (%)	Interviews

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