GÜLŞAH ANGI

PLASTICS PACKAGING WASTE MANAGEMENT and REGULATIONS TURKEY versus EUROPE

Mestrado em Inovação Química e Regulamentação /
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Trabalho efetuado sob a orientação de:
Prof. Daniel Sainz and Prof. Isabel Cavaco

UAlg
UNIVERSIDADE DO ALGARVE

Faculdade de Ciências e Tecnologia

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I declare that I am the author of this work, which is original. The work cites other authors and works, which are adequately referred in the text and are listed in the bibliography.

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Gülşah ANGI

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ABSTRACT

Plastics are used almost everywhere and making our lives much easier thanks to their multiple functionalities. However, due to inadequate production and recycling methods, millions tons of plastic litter are ending up in the earth and oceans every year.

The European Union is taking necessary actions to make an impact and to be able to overcome that problem. In 2015, the EU Commission adopted an 'Action Plan' for a circular economy of plastics. In 2017, the EU Commission declared another goal of ensuring all plastic packagings will be recyclable by 2030. In comparison to the EU, as a big contributor of plastics waste in the region, Turkey's actions were also wondered and so, Turkish plastics waste management system and related regulations have been examined, as well as the European Union's.

Primarily, it has been investigated that the current Turkish waste management regulations are mostly compatible with the European Union ones, as Turkey is adapting its regulations according to the EU requirements. The significant difference between the examined Turkish and the EU regulations was the recycling target ratios for plastic packagings. While Turkish regulation on management of packaging waste was obliged to recyclate min 54% (until 2020) of the plastic packaging waste, the mandatory ratio according to the EU's packaging waste directive was only 22.5% (until 2025). According to the latest data reached, Turkey was recycling 54% of its total plastic packaging waste occurred in 2017 which was equal to the given target. On the other hand, the EU was recycling 40.8% of its total plastic packaging waste occurred in 2016 and that was much higher than their given target ratio.

By considering only the recent 'plastic packagings waste' recycling ratios, it can be interpreted that Turkey's recycling performance is better than the EU average. However, considering both current Turkish and the EU's plastics waste management practices and results, even though there are good plans for the future, it can be concluded that their recent systems are not sustainable and not adequate enough to solve plastics waste problem in our territory everlastingly.

Keywords: Plastics, Waste Management Systems, Waste Management Regulations, Recycling of Plastics, European Union, Turkey.

RESUMO

Os plásticos são usados em quase todo o lado e facilitam muito a nossa vida graças às suas múltiplas funcionalidades. No entanto, devido a métodos inadequados de produção e reciclagem, milhões de toneladas de resíduos plásticos acabam na terra e nos oceanos cada ano.

A União Europeia está a tomar as medidas necessárias conseguir superar esse problema. Em 2015, a Comissão Europeis adotou um "Plano de Ação" para uma economia circular de plásticos. Em 2017, a Comissão Europeia declarou outra meta: garantir que todas as embalagens de plástico sejam recicláveis até 2030. Em comparação com a UE, sendo a Turquia um grande contribuinte de resíduos plásticos na região, as suas ações também foram questionadas, sendo que tanto o sistema turco de gestão de resíduos de plástico como os regulamentos afins foram examinados, assim como os da União Europeia.

Primeiramente, verificou-se que os atuais regulamentos turcos de gestão de resíduos são em grande parte compatíveis com os da União Europeia, já que a Turquia está adaptando suas regulamentações de acordo com os requisitos da UE. A diferença significativa entre as regulamentações turcas examinadas e as regulamentações da UE foi o objetivo relativo à taxa de reciclagem para embalagens de plástico. Embora a regulamentação turca sobre a gestão de resíduos de embalagens tenha como meta reciclar 54% (até 2020) dos resíduos de embalagens de plástico, de acordo com a diretiva de resíduos de embalagens, as exigências da UE eram de apenas 22,5% (até 2025). De acordo com os últimos dados obtidos, a Turquia reciclou 54% de seu total de resíduos de embalagens de plástico em 2017, o que foi igual à meta estabelecida. Por outro lado, a UE reciclou 40,8% do seu total de resíduos de embalagens plásticas em 2016 e foi muito superior à meta estabelecida.

Ao considerar apenas as taxas de reciclagem de resíduos de embalagens de plástico, pode interpretar-se que o desempenho de reciclagem da Turquia é melhor que o média da UE. No entanto, considerando as atuais práticas e resultados da gestão de resíduos de plástico tanto da Turquia como da UE, embora exista um bom plano para o futuro, pode concluir-se que os seus sistemas atuais não são sustentáveis nem suficientes para resolver o problema dos resíduos de plástico no nosso território para sempre.
Palavras-chave: Plásticos, Sistemas de Gestão de Resíduos, Regulamentos de Gestão de Resíduos, Reciclagem de Plásticos, União Europeia, Turquia.

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LIST OF ABBREVIATIONS

B2B	Business to business
ÇEVKO	Turkish Foundation for Environmental Protection and Reappraisal of Packaging Wastes
CF	Cohesion Fund
EC	European Commission
EEA	European Environmental Agency
EPR	Extended Producers Responsibility
ERDF	Regional Development Fund
ESM	Environmentally Sound Management
EU	European Union
EuPC	European Plastics Converters Association
Eurostat	European Union Statistics Office
HDPE	High density polyethylene
LDPE	Low density polyethylene
LLDPE	Linear low-density polyethylene
MDPE	Medium density polyethylene
MoEU	Turkish Ministry of Environment and Urbanization
NWMP	National Waste Management Plan
OECD	The Organization for Economic Co-operation and Development
PAGÇEV	Turkish Packaging Waste Recycling Enterprise
PAGEV	Turkish Plastic Industry Foundation
PCB	Polychlorinated Biphenyl
PCE	Polymer Comply Europe
PE	Polyethylene
PET	Polyethylene Terephthalate
PP	Polypropylene
PRE	Plastics Recyclers Europe
PS	Polystyrene
PVC	Polyvinylchloride
SDGs	Sustainable Development Goals
TOBB	The Union of Chambers and Commodity Exchanges of Turkey
TÜİK	Turkish Statistical Institute
UN	United Nations
UNEP	United Nations Environment Programme

1. INTRODUCTION

1.1 Objective of the Study

The present study aims to analyze the adequacy of current Turkish plastic packaging waste management system and its regulations which are in force and to compare their compliance with the European Union's plastic packaging waste management and legislation system.

Specifically, the objectives of this research project are;

1. Collect information about the current status of Turkish and European Union plastics packagings production markets.
2. Investigate how plastics packagings are treated and recycled as waste in Turkey as well as in European Union.
3. Identify the regulations of Turkey and European Union which are needed to manage their plastics waste management systems successfully.
4. Analyze the performances of Turkish plastics packagings waste management system and regulations along with the European Union's and conclude if they are sufficient enough to overcome the plastics waste problem.

1.2 Plastics and Plastics Waste

1.2.1 Plastics

Plastics are originally polymers which can be made of repeating molecular units of single monomers or the combination of different polymers. Depending on their chemical structure of polymers, plastics can be differentiated as acrylics, polyesters, polyolefins, silicones, polyurethanes, and halogenated plastics. They can be also classified according to their synthesis types or some properties such as the density, thermoplasticity, biodegradability, electrical conductivity or chemical resistance. [1]

Plastics are light, robust, durable and relatively cheap. These outstanding properties make plastics very special materials which can be used in different manufacturing industries such as energy, healthcare, construction, automotive or food. The plastics can have different functionalities depending on the polymer types which have used in their production. [1]

The traditional way to produce plastics is to use fossil feedstocks such as petroleum or natural gas. In the meantime, plastics can also be produced by the alternative feedstocks such as agricultural residues or organic waste. In both cases, produced plastics are recyclable and can be bio-degradable. [1, 2]

Another way to produce plastics is to use secondary materials which are obtained by the recycling of plastics waste. The recycling can be made via mechanical process starting from grinding, washing, separating, drying, re-granulating and compounding respectively. Or plastics waste can be degraded into its monomers via chemical processes. Chemical recycling is especially important for the recycling of contaminated and mixed plastics waste [1]

1.2.2 Circular Economy of Plastics

The lifecycle of products is generally linear and follows the sequence of produce, use and dispose. Considering the problems such as limited resources, climate change or the growing population of the world, this linear lifecycle pattern is not efficient and sustainable at all. Thus, a new approach called ‘circular economy model’ is getting more important to sustain value added products in the market and to eliminate waste generation as much as possible. [1]

The lifecycle of plastics is a long process which starts from the production of plastics materials that are used by the converters to manufacture finished plastics products. These finished products reach to customers after a complex purchasing and selling processes, and end up into garbage in the worst case scenario. According to the circular model, it will not be end of the story, but these plastics waste will be collected and sorted properly to recycle. And the recyclate plastic materials will be used as a raw material again in the system. [1]

The circular model for plastics can be presented as in the following figure; [1]

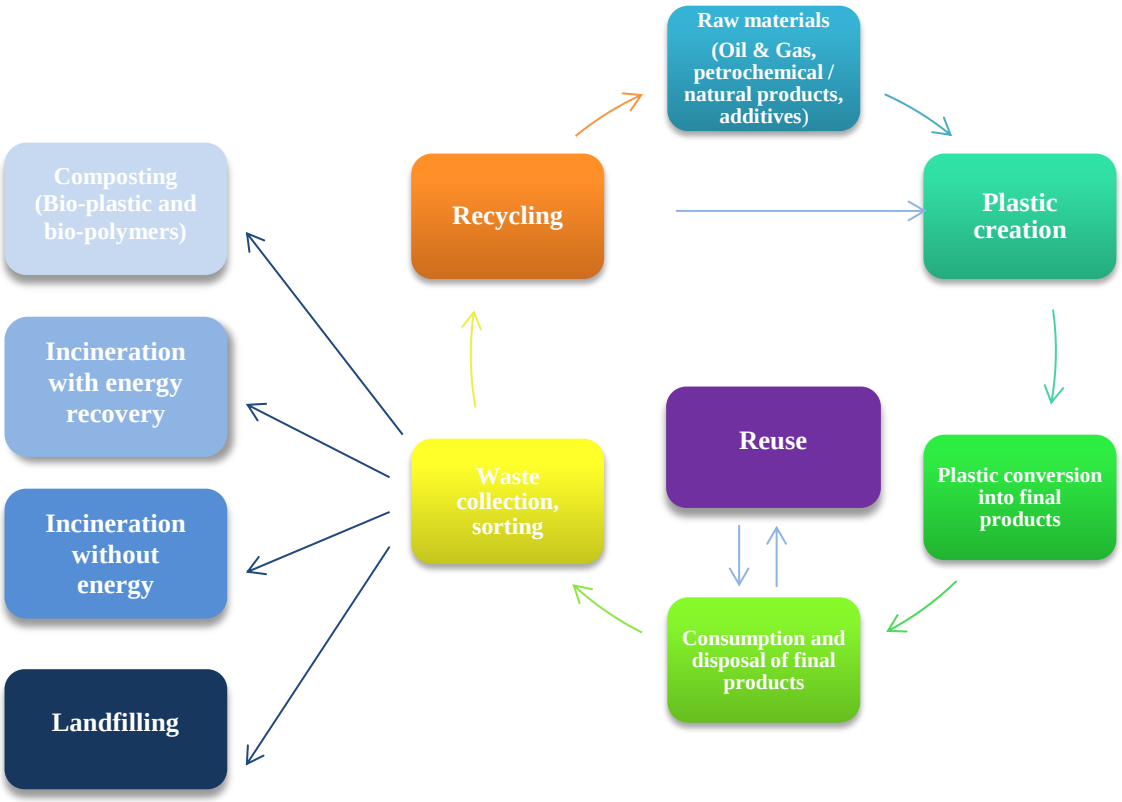

Figure 1.1 Circular Plastics Value Chain (adapted from [1])

In the case of plastics, they are extremely resource efficient along their service life as well as a waste. During their service life they can be repaired or re-used, and when ultimately they become waste, they can be used as a new resource for plastics production, by closing their loop according to circular economy model. [2]

Their usage as secondary raw materials will avoid using more virgin raw materials and that means more energy and the feedstock saving. At the same time, it will help for environmental protection, by leading less greenhouse gas emission. [1]

While even their secondary products are so valuable, their ending up in the landfills has to be restricted, and the most efficient plastics waste management systems that foster recycling have to be established as early as possible. [2]

1.2.3 Plastics Waste

In the current practice, plastics are mainly non-biodegradable and so they can remain in the environment as waste for hundreds of years. Of course, their indestructible existence in the ecosystem may cause possible risks for the environment as well as for the humankind. [3]

According to the researches '10 million tons of litter, mostly plastic, which ends up in the world's oceans and seas annually, turning them into the world's biggest plastic dump, harm the coastal and marine environment as well as aquatic life'. [4]

Marine litter is very harmful for plants and animals in aquatic life, causing even many deaths of creatures. Additionally, the potential hazards of micro-plastics for human health is also a part of discussion now, as toxic chemicals (persistent organic pollutants) which are used in plastics production, can enter into the food chain via micro-plastics and may cause carcinogenic, mutagenic or other health effects on human bodies. [1]

Thus, plastics waste leakage to the environment has to be under controlled immediately and in order to do so more efficient 'Plastic Waste Management' systems have to be established.

1.3 Plastics Waste Management

'The plastic waste management cuts across a number of policy fields, not only the sustainable management of resources, but also climate change, energy, biodiversity, habitat protection, agriculture and soil protection'. [3]

Due to the problems that may have caused by plastics, their waste management must be done in a most efficient way. There are several methods to deal with plastics waste such recycling, incineration (with or without energy recovery), or landfilling. [3]

Among those, the recycling is the most efficient way as the plastics can be used as raw materials again. And besides, it is more energy and resource efficient since they are derived from limited natural sources. As another option, incineration method is used mainly for energy recovery purposes however; it must be prohibited as incineration of plastics may release hazardous chemicals such as cancer causing dioxin and PCB. And also landfilling as

plastics are so valuable to burry and their landfilling may release toxic chemicals in to ground water or soil [5]

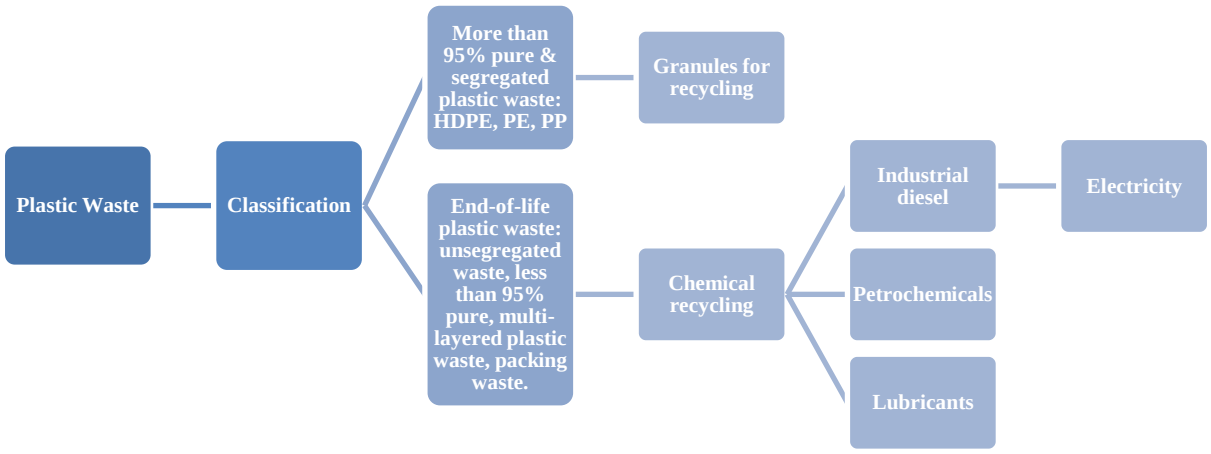

Figure 1.2 Plastics Recycling Scheme (adapted from [6])

Unfortunately, recycling of plastics is not simple. Only less than 20% of plastic waste can be recycled by simple remolding while more than 80% of them can be recycled through pyrolysis or hydrolysis only. The methods which are used for plastics recycling can be divided into four groups and called as primary, secondary, tertiary and quaternary recycling. [6]

Primary and secondary recycling's are physical methods of plastics recycling. Only segregated plastics waste can be recycled with this method, multi-layered or mixed plastics waste cannot be recycled via primary and secondary recycling. Primary recycling cause a change in the structure of its polymer such as reduction or increase in its average molecular weight. Remolding can be an example of this process. [5, 6]

Secondary recycling includes the mechanical recycling, chemical modification, the co-extrusion and the co-injection molding. Mechanical recycling of thermoplastics includes the following steps; collection, manual sorting, chipping, washing and pelleting'. [5]

As, the 80% of the plastics waste generated cannot be recycled via primary or secondary recycling methods, tertiary recycling is the most sustainable method for plastics waste. Tertiary recycling is a chemical method and suitable for all types of plastics waste including

the multi-layer plastics. It causes the production of basic chemicals and fuels by using the pyrolysis and hydrolysis processes. Tertiary recycling allows the energy recovery from waste without burning the plastics. [6]

'Pyrolysis is a physical and chemical decomposition of organic materials at elevated temperatures (400-1000 ^{o}C in low oxygen pressure) in order to produce basic chemicals, fuels and char from the plastics waste. Pyrolizer vaporize the plastics and resulting gas condensed to produce gasoline, diesel and heavy oil. Pyrolysis reduces the volume of waste by 90% or more and does not cause air pollution and requires little space and recovers the energy from waste'. [5]

And finally, quaternary recycling is a method to retrieve the energy from plastics waste by incineration. However, incineration causes very high levels of pollution due to the emissions of harmful chemicals such as dioxins or PCB. Thus, incineration of plastics is banned in most of the developed countries. [5, 6]

1.4 Plastics Waste Management Regulations

In the current system, there is still no global institution which can manage plastics waste starting from their production until the final treatments, neither a harmonised legislation system which will help to control the plastics pollution at the global level. Of course, there are some initiatives, action plans and agreements followed by different countries or groups around the world especially leading by the United Nations and the European Union. [7]

For instance; in 2015, the UN member countries has published their 2030 Agenda including 17 Sustainable Development Goals (SDGs) to achieve until 2030. The 2030 Agenda and its SDGs is requiring a commitment at local, regional and global levels, including partnerships. After their release, the EU and its Member States declared their commitments for the SDGs immediately. And the EU started to play an important role for fostering SDGs, as the sustainability, circular economy, and waste management issues are also the EU's priorities and some of SDG are directly relevant with their targets. [1]

In general, ‘the EU takes an active part in the decision-making processes under the relevant multilateral environmental agreements and provide guidance for all countries especially in some areas such as chemicals and waste management’. [1]

The Basel Convention’s initiatives can be given also as practical examples of the actions taken at global level. For example, the Basel Convention Parties have prepared a toolkit which is called ‘Environmentally Sound Management (ESM)’ that can be used by countries who want to improve their national waste management policies and systems. The ESM toolkit consists of practical manuals, fact sheets, training materials, checklist for self-assessment of national capacity, pilot projects, and case studies to help for developing an efficient waste management system. [1]

To be successful at global level and keep the plastics problem under control, the efforts of the EU itself is not enough unfortunately. Thus, the EU is sharing its circular economy and plastics strategy approaches within other countries as well. In order to do so, the European Commission is having regular policy dialogues with partner countries such as G20 members including China and India. Besides, the neighbors and the EU candidates such as Western Balkan countries and Turkey are the valuable partners to promote these approaches at international level. [1]

2. METHODOLGY

2.1 Methodology

‘The current status of Turkish and the European Union’s plastics waste management systems and their applicable regulations’ was decided as the topic of this reseach project. During the preparation, ‘Plastic Packagings’ sector was selected as a sub-category in order to give more information about how they are processed and treated as waste. It was especially selected since it covers the largest share of the plastics production in Turkey, as well as in the EU comparing to other sub-categories. Plastics are also used in other sectors such as automotive, electric and electronic, construction and demolition, or agriculture. However, all of them have different systems and regulations, different treatment methods and obstacles. That is why this research has mainly more focused on ‘Plastic Packagings’ category.

After the selection of the sub-category, a detailed google search was made in order to reach related data from scientific papers, reports, legislations and news.

The main data regarding to the waste management of Turkey, were obtained from the action plans, reports and regulations published by the Turkish Ministry of Environment and Urbanization, and also the sectoral reports published by different Turkish non-governmental organizations such as PAGEV, PAGÇEV and ÇEVKO.

On the other hand, the data have found regarding to the European Union, based on the European Commission's reports and the action plans about their plastics strategy and its circular economy, as well as the other reports published by the European Organizations such as EuPC, PRE, UNEP, and Greenpeace. Besides, the related EU regulations were obtained by the EURO-Lex system which is the official website for the European Union laws and other public documents.

2.2 Limitations

The biggest limitation which had faced during the preparation of this thesis was to try to compare two different data prepared by different sources and most probably by using different methods.

In the Turkish side, the only available plastic packagings recycling data was belonging to 2017 and prepared by the Turkish Ministry. The report was giving the 'recovered' plastic packagings ratio as 54% but it was not clear that if this data belongs to only 'recycling' or also covers any other results such as the incineration ratios for energy recovery. The 2017 Ministry report was using the 'recovery' ratio word in Turkish, but its latest regulation was using 'recovery' word for 2017 target ratios (54% for plastics) but also 'recycling' word for 2018 (54% for plastics). So, it was not clear if they meant 'recycled' ratio also for 2017 or not. Moreover, the waste statics in general could be reached from Turkish Statistical Institute's website, but it was not including the plastic packaging waste management statistics to be analyzed separately.

On the other side, the European Plastics Manufacturers Association (PlasticsEurope)'s 2018 report was used to obtain the latest EU data from 2016. Additionally, the waste statistics of plastics packaging could also be reached from Eurostat's website. However, the results of PlasticsEurope's report were even different than the results given by the Eurostat. By considering the need of some corrections, PlasticsEurope's data preferred to be used.

As a final limitation, it can be added that all the Turkish regulations were available in Turkish language so, it was hard to translate their names or details exactly into English and compare them with the EU versions.

3. RESULTS

3.1 Turkish Plastics Industry

According to PAGEV (Turkish Plastic Industry Foundation), plastics industry is one of the key drivers of the Turkish economy. 'With over 10 million tons of production, 40 billion dollars in revenue, 5 billion dollars in direct exports and an annual rate of growth that has consistently exceeded 10% over the last decade, the industry is increasingly a major contributor to the economy. The processing capacity of Turkish plastics sector is the 6th in the World and the 2nd in Europe. And it provides employment for 250,000 people in almost 14,000 firms, with 99% being at the SME level'. [8,9]

Turkey is located between the Middle East and the Europe which brings a certain advantage for the Turkish plastics producers as they can reach the main raw material sources from the East easily, while they can sell their cost advantageous products in the European market. [10]

As of 2018, the Turkish plastics industry was still growing. According to the report issued by PAGEV for the first half of 2018, plastics production was increased by 7.2% to 5 million tons in terms of amount, and increased by 9.3% to 19.4 billion dollars in terms of value. During the same period, plastic products exports were increased by 12.8% to 2.4 billion dollars. [8]

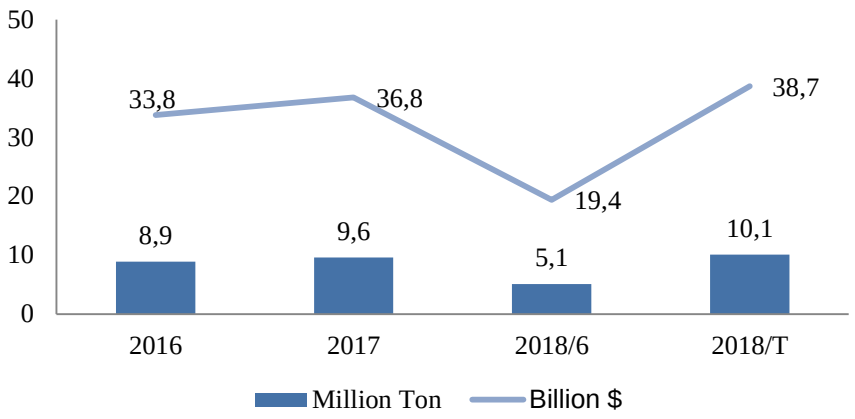

Figure 3.1 Turkish Plastics Products Manufacturing Data **(adapted from [8])**

In the first 6 months of 2018, 5.1 million tons of plastic products were produced in total in Turkey. Amongst this amount; 'Plastic Packaging Products' sub-category had the biggest amount portion within the 2.21 million tons and 'Plastic Construction Materials' sub-category came after within the 1.1 million tons of productions. [8]

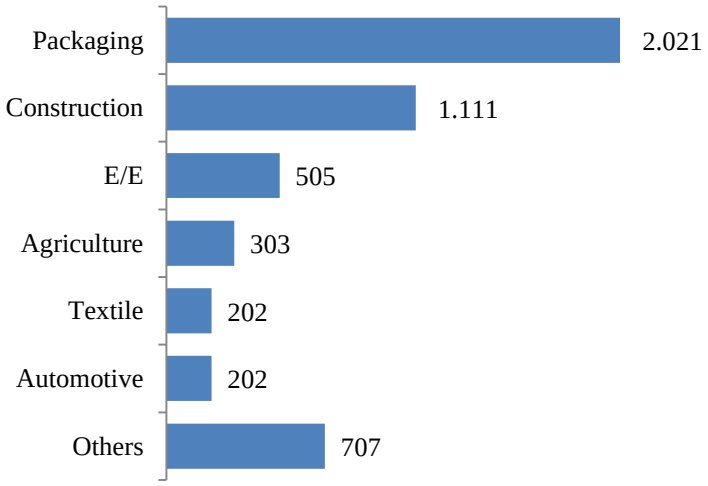

Figure 3.2 Plastic Product Manufacturing by Subsectors – 2018/6 (1000 t) **(adapted from [8])**

3.2 Turkish Plastic Packaging's Industry

According to PAGEV's Turkish Plastics Packaging Materials Industry Follow-Up Report, plastic packaging production is covering 40-53% of the total plastic products manufacturing in leading countries. In 2017, while the world average was 46%, in Turkey this ratio was

40%. After paper and cardboard, plastics are the mostly used raw material for packagings. In developed countries, 1/3 of all products are packaged with plastics. [10]

According to the same report, during 2013-2017, Turkey's plastics packaging market had increased by 3.4% in production, 5.1% in imports, 9.1% in exports, 2.3% in domestic consumption on amount basis. In 2017, 24% of the total production was exported, 14% of domestic consumption was met by imports. [10]

Additionally, during 2013-2017, Turkey's plastics packaging market had increased by 2.4% in imports, 2.7% in exports in value basis. However, the production had declined by 0.7% on average and domestic consumption had declined by 0.8% in this period. [10]

In Turkish plastic packagings industry, different products are manufactured by different sized companies. According to the TOBB database, the total manufacturing capacity of registered companies in 2017 were as below; [10]

Table 3.1 Installed Capacity of Plastics Packaging Industry [10]

Products	# of Companies	Ton M^2	M^2	Meter	1000 Unit
Plastic film	205	200.639	1.036.345.507	421.630.400	
Sheets	137	128.243	342.572.240		
Bottles and Cans	235	86.589			2.008.991
Storage Containers	543	279.737			1.648.000
Packaging bags	734	493.000	1.247.482.460		841.000
TOTAL	**1854**	**1.188.208**	**2.626.400.207**	**421.630.400**	**4.497.991**

According to PAGEV data base, about 61% of the companies who were operating in plastics packagings industry were located in Istanbul. The rest of the companies are generally operating in the below cities; [10]

Table 3.2 Plastics Packaging Products Manufacturers by Location [10]

City	# of Companies	% Share
İstanbul	871	61
İzmir	84	6
Konya	57	4
Ankara	51	4
Bursa	51	3
Gaziantep	42	3
Kocaeli	40	2
Adana	27	2
Denizli	23	1
Mersin	17	1
Kayseri	16	1
Manisa	15	1
Samsun	13	1
Antalya	11	1
Others	105	7
Total	**1423**	**100**

During the last 5 years (2013-2017), cumulative aggregate growth rate of plastic packaging materials production was 3.4% on the amount basis while it was - 0.7% on the value basis. The total production amount in 2017 was 3.8 million tons and its value was equal to 12,7 billion $ according to PAGEV's Turkish Plastics Packaging Materials Industry Follow-Up Report. [10]

Table 3.2 Plastics Packaging Products Production Data [10]

	2013	2016	2017	% Increase 2017/2016	CAGR% 2013-2017
Million Tons	3,3	3,5	3,8	7.1	3.4
Billion $	13,0	11,8	12,7	6.9	- 0.7

According to the same report, plastics packagings were having the highest share in Turkey comparing to the production of other packaging types with a 37% share in total production; [10]

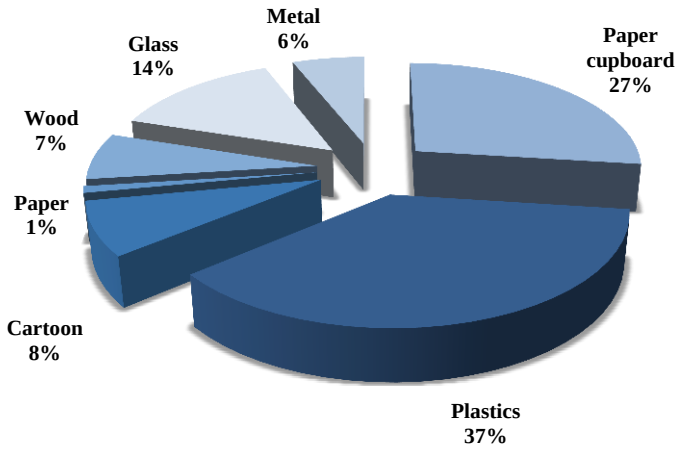

Figure 3.3 Production Percentages of Packaging Materials in Turkey [10]

The annual average increases in plastic packaging materials over the last 5 years (2013-2017) on amount basis as below; [10]

Table 3.3 Supply and Demand Equilibrium in Plastics Packaging Products (1000t) [10]

	2013	2016	2017	% Increase 2017/2016	CAGR% 2013-2017	2018 Expect.
Production	3.327	3.547	3.800	7.1	3.4	3.928
Imports	382	431	466	8.1	5.1	490
Exports	646	864	915	6.0	9.1	999
Domestic Consumption	3.064	3.114	3.351			3.419
Foreign Trade Surplus	263	433	449			509
Export/Production (%)	19	24	24			25
Imports/Domestic Consumption (%)	12	14	14			14
Exports/Imports (%)	169	200	196			204

3.3 Turkish Plastics Waste Management System

In Turkey, 'Waste Management' implementations are under the control of Turkish Ministry of Environment and Urbanization (MoEU). The waste management has been a priority for Turkey since many years and in order to improve the Turkish system, the EU waste management directives had been transposed into Turkey's national legislation system. [11]

According to current regulations, Municipalities in Turkey are the sole responsibles for providing all services regarding to collection, transportation, separation, recycling, disposal and storage of solid wastes, or to appoint others to provide these services. However, while they were fulfilling their duties in collecting and transporting the solid waste to a great extent, they did not show the required level of activity in the solid municipal waste management. This situation has been improving by newly adopted management perspectives according to the 2016 Municipal Waste Management Report in Turkey. [11]

Apart from the municipalities, the industry (producers or suppliers) are also responsible for the collection and recycling of packaging waste they have created/released to the market. [12]

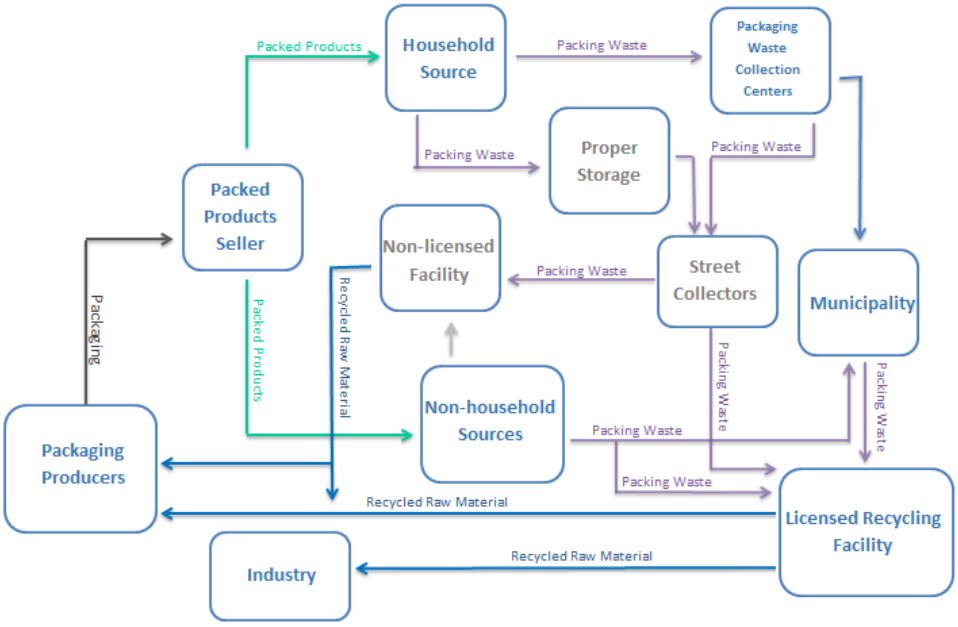

Figure 3.4 Recycling Life Cycle of Packaging Products in Turkey (adapted from [13])

Every year, the producers/suppliers of packaging products (or their authorized organizations) are responsible for collecting and the recycling of packaging product wastes in certain amounts according to targets given by the 'Regulation on the Management of Packaging Waste' in the below table; [12]

Table 3.4 Targets for Recovery/Recycling (%) of Packaging Waste in Turkey per Material [11]

Year	Plastics	Paper/ Cardboard	Glass	Metal	Wood
2016	52	52	52	52	7
2017	54	54	54	54	9
2018	54	54	54	54	11
2019	54	54	54	54	13
2020 and later	55	60	60	55	15

As an obligation of Turkish 'Regulation on the Waste Management', an online 'Packaging Information System' (http://atikambalaj.csb.gov.tr/Yetki/Login) was created for the purpose of establishing an inventory of packaging waste. [14] The packaging producers/suppliers have to upload information about their packaging production and released amounts (production, export, import amounts) to the market, the usage areas, and the and recovery rates until the end of March every year. If they have an agreement within an authorized organization, they have to declare it also online. [15]

The system can be reachable by several users such as the Ministry, provincial directorates of environment and urbanization, packaging producers, suppliers, companies that sell their products into market by packaging, packaging waste separation and collection companies, packaging waste recycling and recovery facilities, authorized organizations and municipalities. [14]

According to the data collected on the 'Packaging Information System' in 2017, below amounts and ratios were obtained according to the Turkish packaging waste management system; [14]

Table 3.5 Produced and Recovered Amounts of Packaging Waste in Turkey (2017) [14]

Waste Codes	Waste Types	Production Amounts (t)	Given Amount to the Market (t)	Recovered Amount (t)	Recovery Ratio (%)
15.01.02	Plastic	3.150.000	915.301	497.089	54
15.01.04	Metal	373.682	142.482	81.146	57
15.01.05	Composite	300.159	96.385	55.410	57
15.01.01	Paper/Cardboard	2.757.848	1.604.823	1.258.128	78
15.01.07	Glass	1.331.265	845.615	193.563	23
15.01.03	Wood	719.741	523.261	113.509	22
	Total	**8.633.055**	**4.127.867**	**2.198.845**	**53**

According to the 2017 packaging waste report, ~8.6 million tons of packaging waste was released to the market by the end of 2017. Among this amount, only ~2,2 million tons of packaging waste was recycled. As the realized recovery ratios were compared with the targets given by law, it was seen that with the exception of glass packaging, all materials were reached their given targets in 2017. [14]

As a part of the waste management system, municipalities are obliged to prepare their own 'waste management plans' since 2008 according to the data collected on 'Packaging Information System'. By the end of 2015, 620 packaging waste management plans which had prepared by municipalities were approved by the MoEU. [11]

In every 5 years, the Turkish Ministry of Environment and Urbanization (MoEU) also has to prepare a 'National Waste Management Plan (NWMP)' according to the information collected from the municipal waste management plans. The NWMP plan examines the current status of waste management activities in the 81 provinces of Turkey. The performances of the municipalities are declared by sharing a real time data. Additionally, projections for the upcoming years are also shared. The latest NWMP has prepared in 2016 and it covers the period of 2016-2023 (an exception for this edition, time period is longer). [12]

According to the NWMP 2016 report, 61.07% of the municipal waste (MSW) was sent to sanitary landfills and 28% was dumped into municipal dumpsites. 11% of the MSW (packaging waste included) was reported as recycled, composted or disposed of by other methods in 2014. [11]

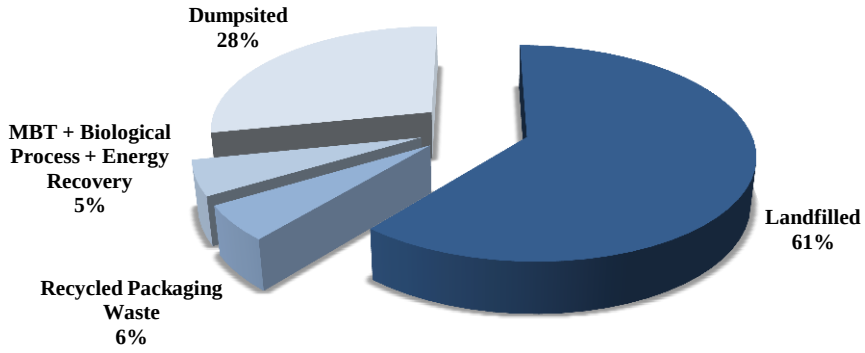

Figure 3.5 The Disposal Methods and Rates of Municipal Waste in 2014 **(adapted from [11])**

It has aimed to reach 35% recycling and 65% landfilling ratios until the 2023 according to the NWMP action plan, also it is aimed to increase the 6% recycled plastics waste ratio up to 12% by the end of 2023. [12]

According to the current waste management system, the collected waste first goes to separation facilities before delivering them to the recycling or landfilling areas. Collection and separation facilities are responsible from the classification and separation of whole waste into the groups and after to deliver to treatment. All those facilities have to get an 'Environmental License' from the MoEU by law to operate. [12]

The changes in the number of 'Collection and Separation' and 'Recycling' facilities in Turkey by years are shown below. While there were only 28 licensed facilities in 2003, this number had increased to 527 for 'Collection and Separation' and to 665 for 'Recycling' facilities in 2017. [14]

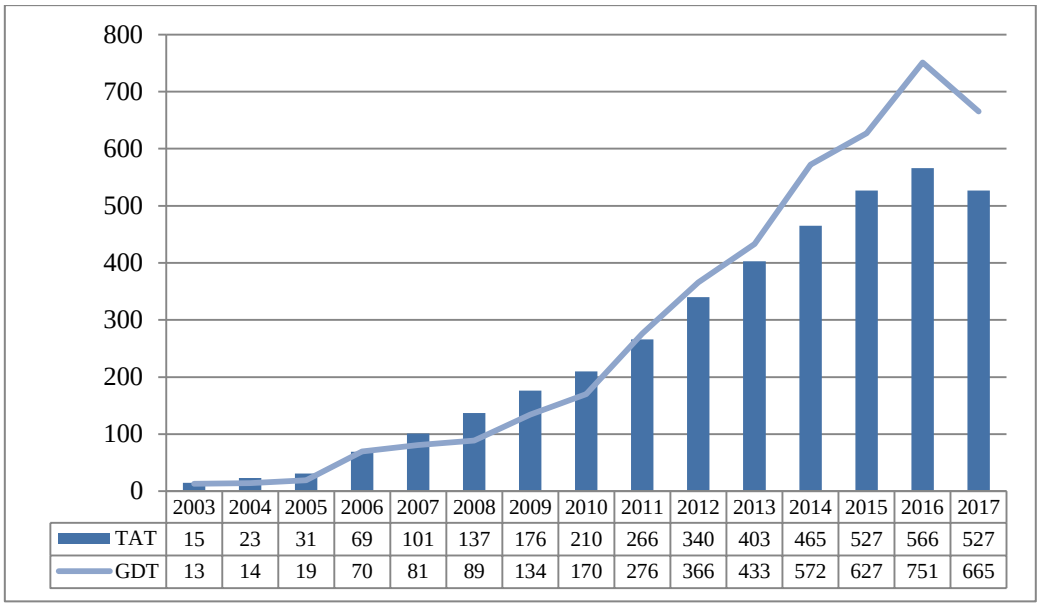

Figure 3.6 The number of 'Collection and Separation (TAT)' and 'Recycling (GDT)' Facilities in Turkey (2017) (adapted from [14])

There are references in the literature which say that the informal recycling sector (unlicensed) could be covering up to 30 % of MSW's material recycling. But there is no more information on the current situation concerning this informal recycling practice. [11]

According to the NWMP report, İstanbul, İzmir, Tekirdağ, Ankara, Bursa, Kocaeli and Antalya were the biggest municipalities with the highest number of 'collection and separation' and 'recycling' facilities for packaging wastes. The report also mentioned that İstanbul, İzmir, Ankara, Antalya, Bursa, Kocaeli and Mersin are the provinces which had highest collection ratios of packaging waste from the first source. [12]

In order to increase the efficiency of separate collection and recycling amounts in the upcoming years, the MoEU brought a new mandatory rule within 'Regulation on the Management of Packaging Waste' for the packaging product producers. The producers have to use min % of below given amounts of recycled raw materials in their productions; [13]

Table 3.6 Annual Mandatory Use of Recycled Raw Materials by Industry (%) [13]

Year	Plastic	Paper/ Cardboard	Glass	Metal
2018	4	25	12	10
2019	6	30	15	15
2020	8	35	20	20

As it is mentioned, ‘Regulation on Management of Packaging Waste’ stipulates that industries that produce packaging goods are obliged to ensure that 54% of the total amount of packaging produced in 2018 is recycled, and that they have to contribute to the recycling costs. Those industries can choose to either recycle those goods themselves or transfer their obligations to authorized organization by paying a fee. An authorized organization has to use those fees to implement policies and to separate wastes at source, in cooperation with municipalities. And municipalities are responsible for planning, managing and tracking the implementations carried out. [16]

In this matter, ‘Çevre Koruma ve Ambalaj Atıkları Değerlendirme Vakfı (ÇEVKO Foundation)’ is the biggest authorized organization in Turkey which collects packaging waste at source as a volunteer to recover since 2005. Since then, they have provided the recycling of almost 6 million tons of packaging waste. [16]

As an authorized organization, ÇEVKO Foundation develops activities regarding the separate collection of packaging waste at source in cooperation with municipal administrations and licensed companies on behalf of the packaging producers and economic operators which put packaging on to the market it represents. ÇEVKO Foundation, having taken over the recovery responsibilities of the industry, carries out its activities on contractual basis with many economic operators. [16]

ÇEVKO foundation is now working on recycling together with 162 county municipalities that have the highest population in Turkey. With their 51 members among whom there are the greatest firms of Turkey, they are fulfilling the recycling obligations of approximately 1,900 companies. [16]

At the same time, ÇEVKO Foundation is working together with all concerned parties, mainly their foundation members for the dissemination of the “Zero Waste” Project of the Environment and Urbanization Ministry of the Turkish Republic nowadays. [16]

3.4 Plastics Waste Management Regulations of Turkey

The Turkish Republic waste legislation is structured based on two overarching legislations; [17]

- ✓ The Environmental Law (08.11.1983- 2872)

✓ Regulation on the Waste Management (02.04.2015-29314 amended 23.07.2017-30016)

The rest of the specified waste management legislations are organized under these two main legislations. But only plastics waste management related ones will be mentioned in this chapter. [17]

Table 3.7 Plastic Waste Management Related Regulations of Turkey [17]

National Acts	Main Content
The Environmental Law (08.11.1983- 2872) [18]	As the framework law, it defines the rules and principles for environmental protection, addresses the responsibles and authorized institutions and organizations, determines the processes for the implementation and establishes the punishments for the improper acts and the liabilities.
Regulation on the Waste Management (02.04.2015 29314) And its amending Regulation (23.07.2017-30016) [15]	This regulation aims to ensure an efficient waste management in each and every phase from their formation to their disposal. It sets forth provisions regarding the reduction, reuse and recycling of waste. It covers all electronic items, packages, vehicles, batteries and battery products.
Regulation on the Management of Packaging Waste (27.12.2017 - 30283) [19]	This regulation aims to determine the technical and administrative principles of all kinds of packaging and packaging waste management. It defines the rules for the reduction of packing wastes by recycling, separate collection at the source, carrying and decomposition.
The Municipality Law (3.7.2005 - 5393) [20]	Municipalities are responsible to provide all services regarding to the collection, transportation, separation, recycling, disposal and storage of municipal waste, or to appoint others to provide these services. They are responsible to prepare waste management plans.
The Metropolitan Municipality Law (10.7.2004-5216) [21]	Metropolitan municipalities are also responsible to implement the waste management plans to make sure that waste are collected at source, recycled, reused, or stored and removed accordingly. And they have to establish appropriate facilities, or to make sure that they are established by others, so that these services can be fulfilled.
Regulation on the Landfill of Waste (26.03.2010 – 27533) And its amending Regulation (11/3/2015-29292) [22]	Technical principles for landfill facilities and the procedures and principles regarding the acceptance of wastes to landfill facilities and the regular storage of wastes, the measures to be taken, the inspections to be carried out and the responsibilities to be taken.

The first particular regulation on packaging waste management came into force in 2004 with the “Regulation on the Management of Packaging Waste” and was revised lately in December 2017. The aim of the regulation was to minimize the generation of packaging waste and to also increase the rate of recycled packaging waste which cannot be avoided within the method of production. The regulation also includes principles and standards for packaging waste to be collected separately at its source, then sorted and transported within a certain system. [11]

Finally in 2015, the ‘Regulation on the Waste Management’ was came into a force (also amended 23.03.2017-30016) and set the framework of waste management in Turkey, from waste generation to disposal so that the procedures are followed in an environmentally sound way. [11]

According to the ‘Metropolitan Municipality’ and ‘Municipality’ laws, municipalities are the responsibles for providing all services regarding to the collection, transportation, separation, recycling, disposal and storage of solid wastes, or to appoint others to provide these services. [11]

Turkey does not have a federal character, thus all legislations are valid and binding throughout the country and there are no regional waste acts. [17]

3.5 The European Union Plastics Industry

According to Association of Plastics Manufacturers (PlasticsEurope) ‘2018 Plastics - Fact Report’, the European plastics industry consists of plastics raw materials producers, plastics converters, plastics recyclers and plastics machinery manufacturers which are located in the 28 EU Member States. The European plastics industry provides a direct employment to over 1,5 million people within 60,000 operating companies (most of them SME’s), having annual turnover ~350 billion Euros and ~17 billion Euros trade balance in 2017. [2]

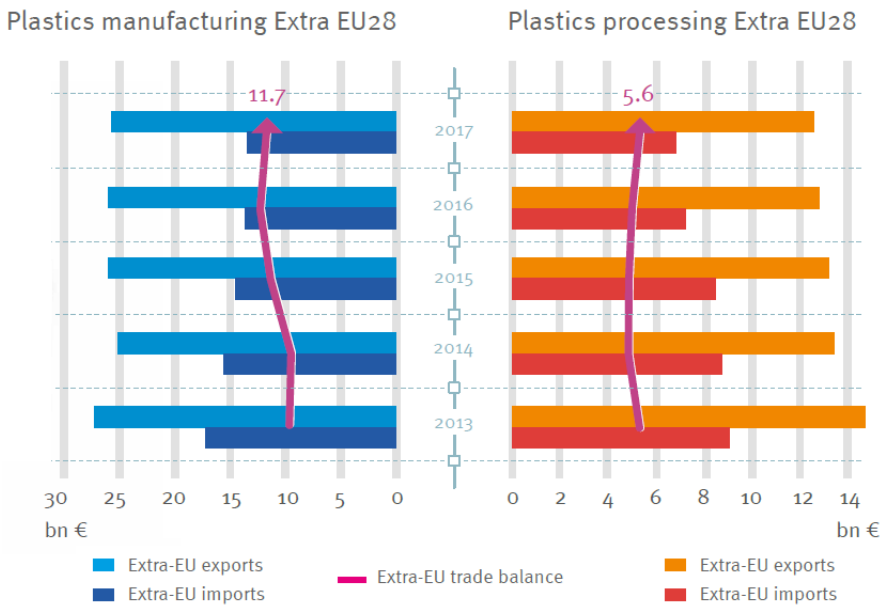

Figure 3.7 Plastics Manufacturing and Processing Trade Balances of EU28 [2]

The total plastic production data of Europe (EU28+Norway/Switzerland) in 2017 was 64,4 million tons, while the total production of the world was 348 million tons (including plastic products such as thermoplastics, polyurethanes, thermosets, adhesives, coatings and sealants but not including PET fibers, PA fibers, PP fibers and polyacryls-fibers). China was the biggest plastics producer (29,4%) in the world, followed by Europe (18,5%) and NAFTA (17,7%) region. [2]

According to the same report, the European plastics industry has ranked as 7th biggest industry in Europe in terms of 'added value' which is at the same level as the pharmaceutical industry, and very close to the chemical industry. The European plastics industry contributed close to 32,5 billion Euros to public finances and welfare in 2017. [2]

As it can be seen from the below figure, the main trade partners of the European plastics industry are; the USA, China, Korea, Turkey, Russia, Switzerland, Saudi Arabia and Japan. For the plastic manufacturing products, the EU was mainly importing from the USA while was exporting to Turkey at most. On the other hand, for the plastics processing products side, the EU was mainly importing from China and exporting them to the USA. [2]

Figure 3.8 Trade Partners of the European Plastics Industry (2017) [2]

According to the below figure, the biggest European countries such as Germany, Italy, France, Spain, UK and Poland respectively were covering almost 70% of the European plastics converter demand (51,2 MT) in 2017. [2]

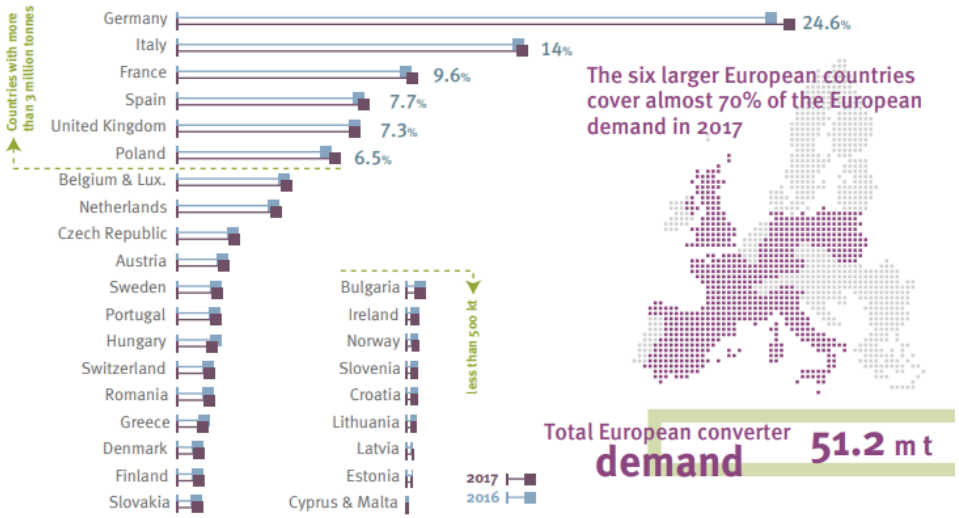

Figure 3.9 Distribution of EU Plastics Demand by Country (2017) [2]

Within Europe, plastics were primarily used in packaging sector (39,7%) while secondly in the building and construction (19,8%) followed by an automotive sector (10,1%) in 2017. Apart from them, electrical and electronic, household and agriculture sectors are the other ones where plastics were mainly used. [2]

Figure 3.10 Distribution of EU Plastics Demand by Sectors (2017) [1]

The plastic end products are mainly composed of a great variety of plastic materials (thermoplastics or thermosets) in order to meet their very different needs. In Europe, 'polypropylene' was the most commonly used (19,3%) thermoplastics type in 2017 that was mainly used in plastics packagings, automotive and construction sectors. According to the same data, 'Polyethylene' was the second mostly used resin type (LDPE + LLDPE in total 17,5% and HDPE + MDPE in total 12,3%) for the production of plastic packagings, household and construction materials in general. [2]

Figure 3.11 Distribution of EU Plastics Demand by Polymer Types (2017) [2]

3.6 The European Union Plastics Packaging Industry

In 2017, 'Plastics Packaging' was covering the biggest part (39,7%) of the plastics production in the EU. According to the below figure, the most commonly used polymer types during the plastics packaging's productions are LDPE and LLDPE which are followed by HDPE, PP and PET. [2,3]

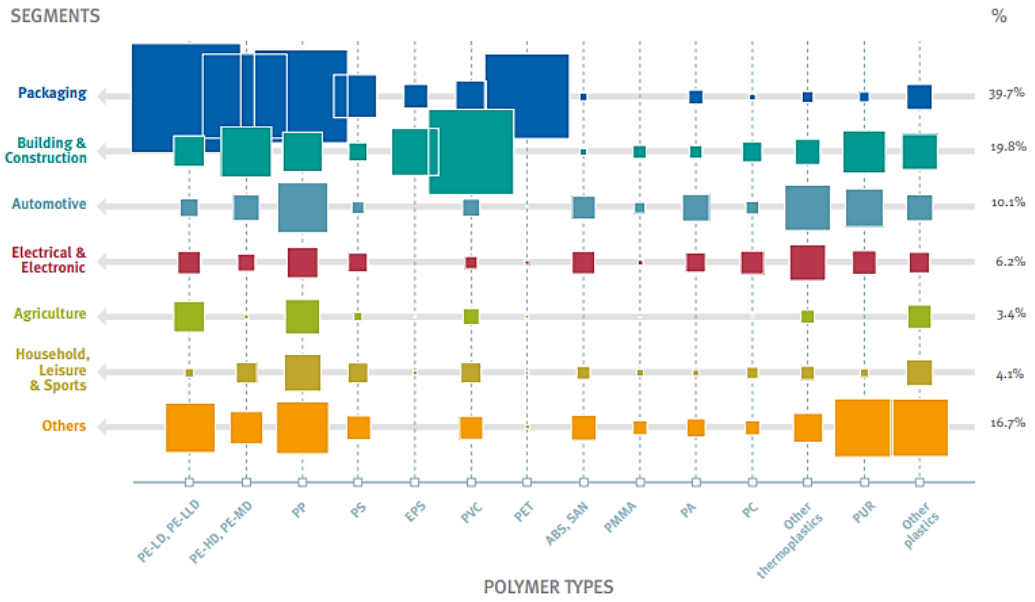

Figure 3.12 Distribution of EU Plastics Demand by Sectors and Polymer Types (2017) [2]

Plastics Packaging's are usually produced by the combination of different polymers and also other materials and adhesives have to be used. For example, plastic bottles are mainly composed of PET while plastics caps are generally composed of PE. Their labels around may be composed of also another type of plastic film such as PS, PVC and PP, or even a paper. All of these materials have very different properties and needs to be recycled differently. [3]

3.7 The European Union Plastics Waste Management System

During the last decade, around half of the plastics waste collected in the EU for recycling was exported to third countries due to the Europe's insufficient domestic recycling capacity, higher cost of recycling and the inadequate quality of the sorted waste. [1]

In between 2006-2016, plastics waste recycling in Europe had increased by almost 80%, landfilling decreased by 43% and energy recovery increased by 61%. However, reuse and recycling of end-of-life plastics still remains low, particularly when it is compared to other materials such as paper, glass or metals. [1, 2]

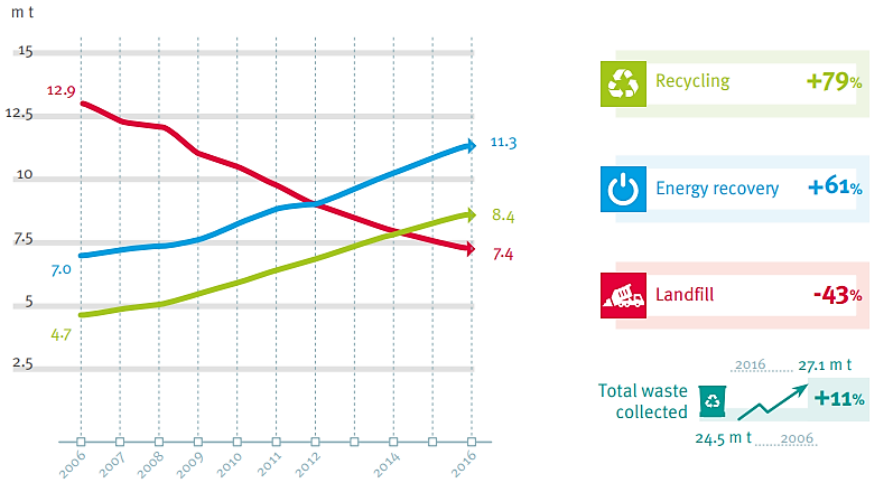

Figure 3.13 The EU's Plastic Waste Treatment Evolution (2006-2016) [2]

In 2016, the EU generated about 27,1 million tons of post-consumer plastics waste of which only 31.1% was recycled and that was the first time, more plastic waste was recycled than landfilled (27.3%). However, still 37% of the plastics waste collected in the EU for recycling were exported to other countries. [1, 2]

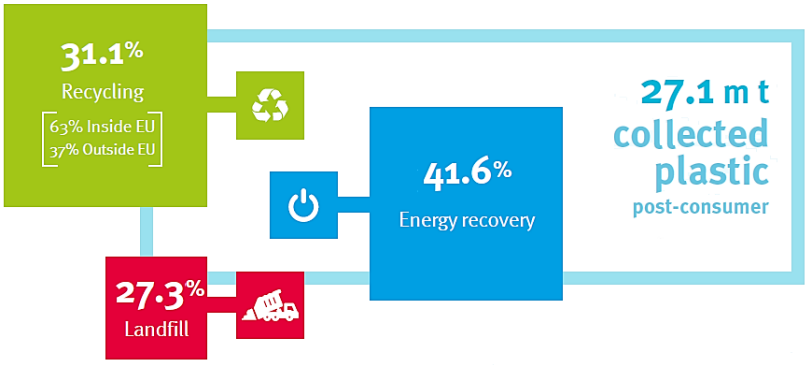

Figure 3.14 The EU Plastic Waste Treatment Values (2016) [2]

China used to be the primary address of the EU's plastics waste collected where 85% of the plastic waste used to export to China. [1] However, China decided to ban the imports of household plastic waste and 23 other kind of solid wastes at the beginning of 2018, as part of a campaign against foreign waste and environmental pollution. After the Chinese plastic waste import ban, the global plastic waste trade has dropped 50% in 2018 comparing to 2016.

The majority of the plastics waste was re-directed to less regulated countries such as Malaysia, Thailand, Vietnam, Indonesia, India, Taiwan, South Korea, and Turkey. [23]

Although the recycling performance of plastics waste in the EU is in progress, there is still plenty of room for an improvement. A more ambitious target was needed to increase the recycling rates of plastics waste and actually that ratio has increased by the amendment to the Packaging and Packaging Waste Directive (by the end of 2025; 50% and the end of 2030; 55% of the plastics packaging waste have to be recycled). [1]

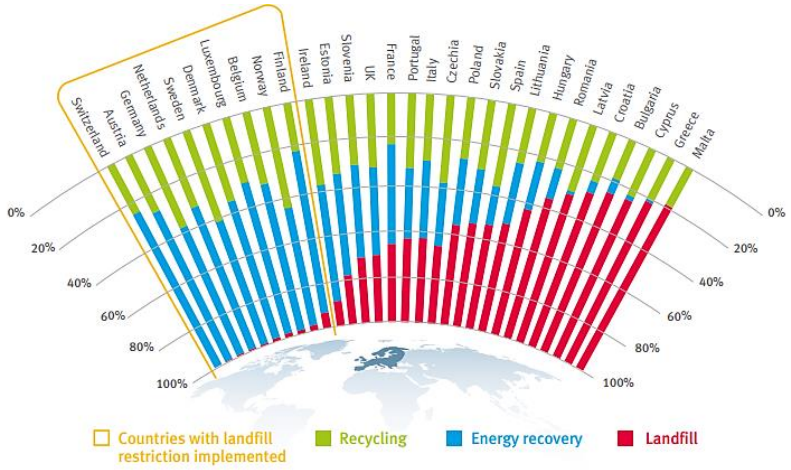

Figure 3.15 The EU Plastic Waste Rates of Recycling, Energy Recovery and Landfill per Country (2016) [2]

The EU countries which are having landfill restrictions of recyclable and recoverable waste have, on average, higher recycling rates of plastic post-consumer waste comparing to ones which do not have land fill bands. [2]

In between 2006-2016, plastic packagings waste recycling in Europe had increased by almost 75%, landfilling decreased by 53% and energy recovery had increased by 71%. [2]

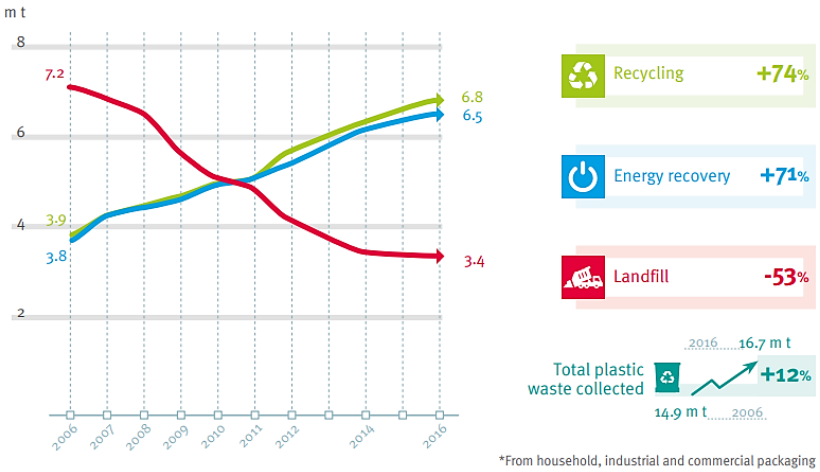

Figure 3.16 The EU's Plastic Packagings Waste Treatment Evolution (2006-2016) [2]

In 2016, 16.7 million tons of plastics packaging waste were collected through official schemes in order to be treated. Only 40.8 % of the plastics packaging waste were recycled while 20.4% of them landfilled and 38.8% of them used for the energy recovery. [2]

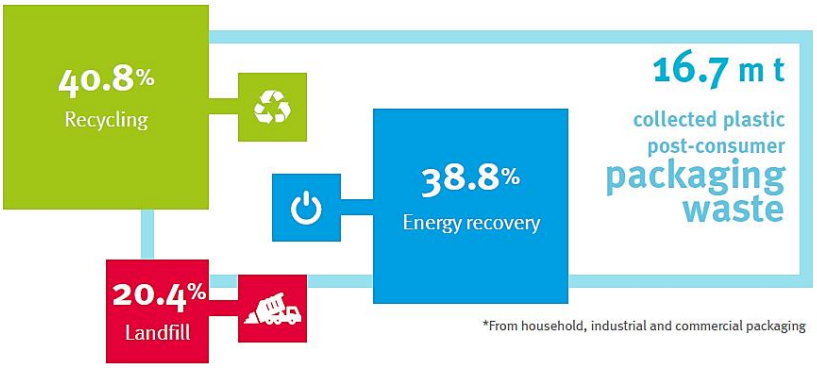

Figure 3.17 The EU's Plastic Packaging Waste Treatment Values (2016) [2]

The recycling rate of plastics packagings generally lowers comparing to other packaging materials. In 2015, while the average packaging recycling rate was 65%, metal recycling ratio was 76%, paper and cardboard recycling ratio was 83% and glass packaging recycling ratio was 73% separately. One of the reasons for the low recycling rates of plastics packagings is the use of different plastic polymers (e.g. PP, PET, and PVC) in their productions depending on the functions of the packagings. The diversity of polymers, as well as the presence of multi-material and multi-layer packaging, make their recycling more difficult as it requires a better separation or extra processing and that creates a problem for to achieving economies of scale. [1]

In 2016, the average EU recycling rate for plastic packaging waste was 40.8% that was well above the ratio of 22.5% requested from EU countries according to the EU Packaging Waste Directive. Czechia was the only country who had achieved a recycling rate of more than 50% and Germany was the second by the addition of its feedstock recycling ratio. [2]

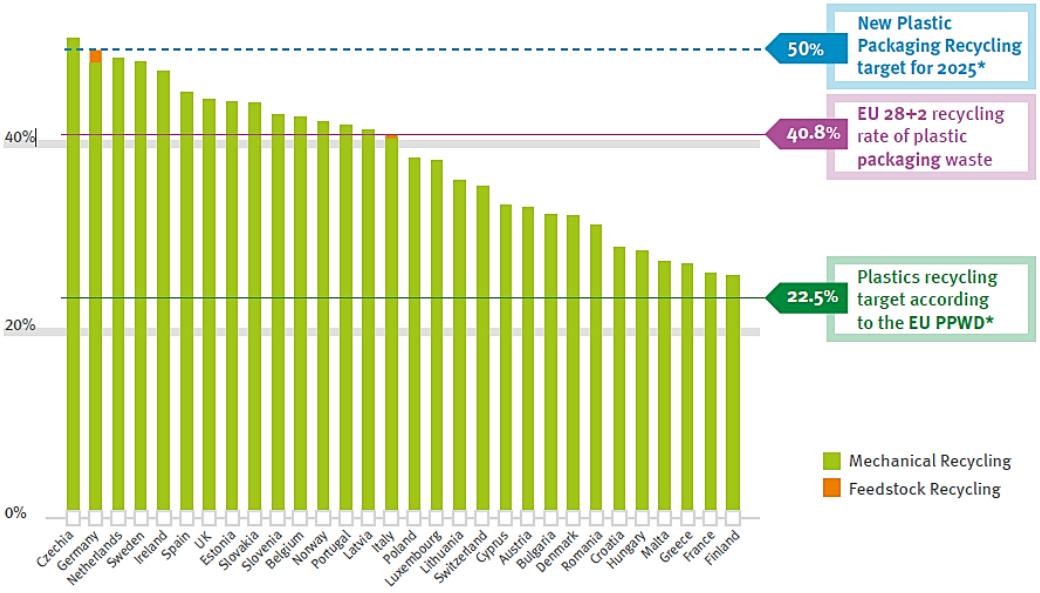

Figure 3.18 The EU Plastic Packagings Recycling Rates per Country (2016) [2]

For example; in Germany, 3 million tons of plastic packagings waste was collected through official schemes in order to be treated in 2016. From this amount only 50% were recycled and 49.9% was used for the energy recovery. [2]

In United Kingdom, 2.3 million tons of plastic packaging waste was collected through official schemes in order to be treated in 2016. From this amount while only 46% were recycled, 33% was used for energy recovery and 21% was landfilled. [2]

In Italy, 2.2 million tons of plastic packaging waste was collected through official schemes in order to be treated in 2016. From this amount while only 41% were recycled, 45.2% was used for energy recovery and 13.8% was landfilled. [2]

In France, 2.2 million tons of plastic packaging waste was collected through official schemes in order to be treated in 2016. From this amount while only 26.2% were recycled, 44.6% was used for energy recovery and 29.2% was landfilled. [2]

In Spain, 1.5 million tons of plastic packaging waste was collected through official schemes in order to be treated in 2016. From this amount while only 45.4% were recycled, 16.4% was used for energy recovery and 38.2% was landfilled. [2]

In Poland, 1 million tons of plastic packaging waste was collected through official schemes in order to be treated in 2016. From this amount while only 38.5% were recycled, 33% was used for energy recovery and 28.5% was landfilled. [2]

3.7.1 Reasons of Low Recycling Ratios of Plastics in the EU

As of today, only 4-6% of the EU plastics raw material demand is covered by the recycled plastics and that is approximately equal to 3.5 million tons/year. There are different reasons that lead businesses to use less recycled plastics but it is changing recently due to the increasing awareness of the circular economy and the sustainability concepts. [1, 3]

In 2017, the European Plastics Converters Association (EuPC) had launched a survey to learn more about the use of recycled plastics in the European plastics industry. The survey was completed by the help of Polymer Comply Europe (PCE) and they had reached 485 participants from 28 different countries. [24]

This survey was giving detailed information about the current status of recycled plastics materials throughout the whole plastics value chain and was concluding the main reasons of having low plastics recycling ratios in the EU. And the results were as below; [24]

1. Lack of sustainability mindset: The European plastics converting companies stated that only 27% of their customers were sufficiently aware of the benefits or the needs of using recycled plastics in their production. The survey also mentioned that 76% of the respondents were currently using recycled plastic materials and 75% of them were planning to increase their usage of recyclates. On the other hand, 64% of the companies who did not use recycled plastic materials were planning to use in near future.

2. Insufficient Recycled Product Quality: The quality of recycled plastic materials remained the biggest barrier to use more recyclates as raw materials. Almost 60% of the European plastics converting companies found it very hard to supply recycled plastic materials which have an acceptable quality.

3. Inadequate Regulatory Framework: The current EU regulations needed to be changed to support the use of recycled plastic materials in a better way. Almost 60% of the European plastics converting companies were thinking that the current regulations were not suitable to support a stronger use of recycled plastic materials.

According to the results of this survey, the primary reason for low recyclate rates is the mind sets of the companies which are far from a real 'Sustainability' approach. Plastics packagings which include higher amounts of recycled materials are not preferred by the companies because the packagings are their principal marketing tools to differentiate from other competitors. Of course, there are some sectors that packagings made of recyclates cannot be used due to the safety issues, but apart from that most of the producers are hesitant to use recycled materials for their packagings due to the aesthetical aspects such as color or odor. [1]

Plastics packagings which include higher recyclates are mostly used in Business to Business (B2B) sectors because of the less safety concerns. On the other hand, food packaging is the sector which plastics are mostly used, but due to the food safety and hygiene concerns, the use of recycled plastics in food packaging is almost impossible. [1, 3] Packaging materials that are used in the food sector, whether they are virgin materials or recycled, have to comply legal requirements and the recycled packagings are not preferred as it is very difficult to control their origin and composition comparing to virgin raw materials. Recycled plastics may contain incidental contaminants that can originate from multiple sources and these can affect the quality and safety of recyclates. [1]

As the surveyors are complained, to find high quality recycled plastics that are sufficiently clean and homogenous is not easy. The recyclers generally enable to have pure and clean raw materials from the tertiary and secondary packagings, as they are produced in large quantities and generally composed of one single polymer. However, for the primary packagings it is more complicated and not possible. [1]

Even though, it is easier and advantageous to use tertiary and secondary packagings for recycling, their potential is not fully used also. According to the European Commission's 'European Strategy for Plastics in Circular Economy' report, for example clean plastic films, which have significant recycling potential, are not collected at all in most of the Member States. So, by increasing the volume of clean plastic waste collected around the EU, higher quality recyclates can be more obtained as its consequence. [1]

In some other cases, it is not easy to find a pure recyclate which is not contaminated or mixed by other products. For example, PET and PVC have many problems with cross contamination as they appear visually very similar to one another. They also have the same specific gravity, therefore the use of conventional float and sink techniques may not be successful in separating them. Separation is very important as just a small amount of PVC can seriously impair the integrity of PET melted plastic. [3]

In the meantime, trends in recycling industry show that PET bottles and PE containers are the drivers of the plastics waste recycling industry. In contrast, despite being the fastest growing plastic type for use in the packaging, electrical and electronics, and automotive sectors, PP still shows a low recycling rate due to a number of technical issues. PP comes in very many types which make its separation and reprocessing into new products more demanding; also, PP is often used with other plastics, metals or other materials, which makes its recovery and separation very difficult. [3]

Additionally, over the last five years the price index has almost doubled and a further strong increase in plastic prices is expected in the medium term due to rising crude oil prices. Thus, plastics recycling is getting more attractive due to it's the potential environmental as well as its increasing economic benefits. [3]

3.7.2 The EU Strategy to Increase the Recycling Ratios of Plastics

According to the Europe's 2020 strategy, the aim is to turn the EU into a smart, sustainable and stronger economy delivering high levels of employment, productivity and social attachment. In other terms, the EU wants to create more resource efficient, greener and more competitive economy. In this regard, prepared 'Circular Economy Action Plan' and the

‘Plastics Strategy’ of the EU can be considered as the complementary of their 2020 strategy. [1]

In order to achieve these ‘Circular Economy’ goals, the recycling ratios in Europe have to be increased. And as they have mentioned, low recycling ratios are because of the wrong mindset of the people who use or produce plastics primarily, but more importantly, there are also technological or infrastructural obstacles that have to be overcome in order to increase the recycling ratios. [1]

Across the EU, every country has a diverse infrastructure capacity, logistics system and waste management practices because of the different technical, economic and social reasons. First of all, collection and sorting of post-consumer plastics waste are complex issues and not easy to implement. Thus, a well-designed, good functioning waste management system has to be settled and separate collection of plastics waste has to be ensured to maximize the recovery of resources and to prevent their release to the environment. [1]

According to one study undertaken in 2015 within the EU, the methods which are used to collect different waste streams and the practical implementation of the obligations vary a lot across the 28 EU Member States. According to study results, only 18 Member States collect plastics via door-to-door systems. Among these countries only 4 of them collect plastics as a separate fraction but all others apply co-mingling with one (metal), two or three other fractions. On the other hand, 6 Member States collect plastics (five together with metals) via bring-points. And unfortunately, 4 Member States do not collect plastic separately from residual waste within the main collection system. [25]

The same study concluded that the collection of plastics as a single fraction within door-to-door collection system delivers the best outcome both in terms of quality and quantity of the collected waste. Even though the collection costs are higher, the treatment costs are lower and higher revenues can be earned from the recyclates. By considering, all these results, door-to-door collection should be more applicable within the Member States. [25]

In addition, everyday more and more municipalities are starting to apply pay-as-you-throw-schemes which provide strong incentives for the waste prevention, correct separation of waste and cleaner fractions which are easier to recycle. [1]

According to the European Commission's 'European Strategy for Plastics' report, although approximately 2/3 of all plastic packaging are recyclable, only 30-40% of them are recycled in practice and almost 50% of the plastics waste collected in the EU is exported to other countries for a treatment. Namely, the EU countries have to make serious investments and technology development to upgrade their waste management infrastructure starting from the collection and sorting of the waste and also to build new recycling plants or to increase the capacity and efficiency of current ones. [1] In this aspect, the latest figures show that the EU will need to build 250 sorting facilities and 300 recycling facilities by 2025 regarding to the European Commission Head Representative Gerry Kiely's speech for 'Coastwatch Annual Event' in 2018. [26]

Of course, all these efforts and developments require huge amount of money to be invested. And that is the main problem of the EU municipalities in order to establish effective waste management systems. At this point, there are some sources named as the 'European Structural and Investment Funds (ESI Funds)' which are used to support the economic development of the EU countries, in line with the objectives of the Europe 2020 strategy. Within this respect, the EU countries that need money to improve their waste management and recycling systems, can apply for two of them called European Regional Development Fund (ERDF) and Cohesion Fund (CF) in general. These funds support investments in innovation, constructing new and upgrading existing infrastructure, increasing recycling capacity of usually non recycled plastics, and etc. [1]

During 2014-2020 period, the EU have allocated a total of 36 billion € from these two funds for their environment and resource efficiency budget, and 41 billion € for their research and innovation projects. And some of the money that allocated will be used to increase the waste recycling capacities of each member states as 5.79 million tons/year more. [1]

Additionally, the EU has another research and innovation programme called 'Horizon 2020' which will invest more than 200 million € in plastics research and innovation between 2018 and 2020. According to their strategy, this money will be used mainly for the development of smarter and more recyclable plastic materials, more efficient recycling processes, removal of the hazardous substances and contaminants from the recycled plastics, or solutions addressing the problem of micro-plastics. [1]

3.8 Plastics Waste Management Regulations of the EU

As it has mentioned before, one of the reasons for having a low plastics recyclate rates in Europe, was because of the lack of legislations according to European survey results declared by the EuPC in 2017. [24]

Fortunately, 'The European Commission has adopted an ambitious 'Circular Economy' package, which includes revised legislative proposals on waste. The revised legislative proposal on waste sets clear targets for the reduction of waste and establishes a passionate and credible long-term path for the waste management and recycling. To ensure an effective implementation, the waste reduction targets in the new proposal are accompanied by concrete measures to address obstacles on the ground and the different situations across the EU Member States'. [1]

Of course, the legislations are not usually targeted specifically the plastics waste only. And so, it always limits the incentive to recycle plastics waste while other elements of the waste stream such as paper or glass can meet weight-based targets far more easily and quickly. [3]

For this reason, there is a need for an establishment of quality standards specifically related to plastics waste management and recycled plastics. The European Commission has launched a preliminary study in this regard. If the mentioned necessary actions such as, developing quality standards, ensuring traceability, improving design for recyclability, enforcing the obligation of separate plastic waste collection and sorting, and certification can be taken, it will help a lot to make the whole plastics value chain more circular. [1]

The Commission has committed to work with the European Committee for standardization and to develop quality standards for sorted plastics waste and recycled plastics. Setting standards for plastic waste and recyclates will be coupled with certification schemes of recycling plants. A certification scheme for plastic recycling plants will bring an additional benefit for increasing the quality of the supply and it will also allow the demonstration that waste exported from Europe to non-OECD countries is treated in an environmentally sound manner. [1]

The Commission is continuously promoting the right implementation of the 'Waste Hierarchy' where reuse and recycling should be preferred instead of the incineration and the landfilling. [1]

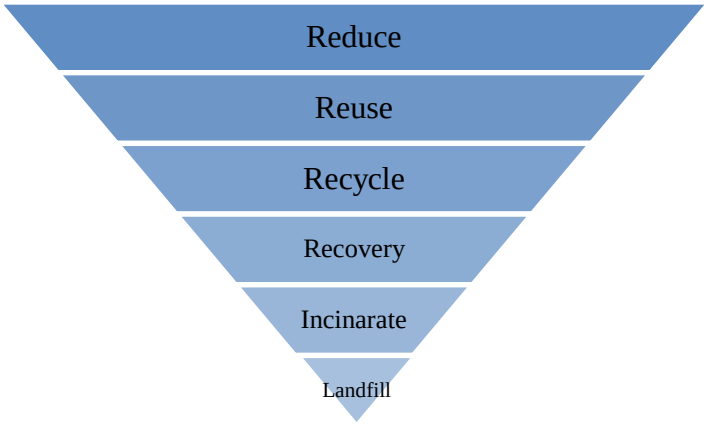

Figure 3 Waste Hierarchy [3]

Generally, the plastics waste management crosses with a number of other policy fields such as sustainable management of resources, climate change, energy, biodiversity, habitat protection, agriculture or soil protection. And thus, different legislations should be considered while plastics waste management is an issue. The below table provides an overview for the existing EU legislations that have to be followed to reduce the environmental impacts of plastics waste. [3]

Table 3.8 Plastics Waste Management Related Regulations of EU [3, 27]

Regulations	Main Content
Directive 2008/98/EC on Waste and Repealing Certain Directives (EU Waste Management Law) [28]	This directive aims to protect human health and the environment against harmful effects caused by the collection, transport, treatment, storage and landfilling of waste.
Directive 1994/62/EC on the Packaging and Packaging Waste [29] + Directive (EU) 2018/852 amending Directive of 1994/62/EC [30]	The directive as amended covers all packaging placed on the European market and all packaging waste, whether it is used or released at industrial, commercial, office, shop, service, household or any other level, regardless of the material used. It requires the return and/or collection of used packaging in order to meet targets for the recovery and recycling of this material. It aims to contribute improving the quality of the environment, to protect human health, to protect resources, to ensure the functioning of the internal market and restrictions on competition within the EU.
Directive (EU) 2015/720 on Reducing the Consumption of Lightweight Plastic Carrier Bags [31]	Directive (EU) 2015/720 amends Directive 1994/62/EC on packaging and packaging waste. It sets out ways and targets to reduce the consumption of lightweight plastic carrier bags, including imposing charges or setting national maximum consumption targets.
Regulation (EU) No 2011/10 on Plastic Materials and Articles Intended to Come into Contact with Foods [32]	This regulation is relating to plastic materials and articles intended to come into contact with food, establishes a list of monomers and other substances, such as additives, that are permitted for use in the manufacture of food packaging.
Regulation (EC) No 282/2008 on Recycled Plastic Materials and Articles Intended to Come into Contact with Foods [33]	This regulation covers the use of recycled plastic materials and articles which come directly into contact with food. The materials and articles covered here are also subject to Regulation (EU) No 10/2011 on plastic materials intended for food packaging.
Regulation (EC) No 2150/2002 on EU Waste Statistics [34]	The regulation covers the production of statistics by EU countries and the European Commission in their respective fields of competence in the waste generation and the recovery and disposal of Waste.
Directive 1999/31/EC on the Landfill of Waste [35]	This directive aims set a combination of intermediate and long-term targets for the phased reduction of biodegradable waste going to landfill, and banned the disposal to landfill of certain materials. It also requires the pre-treatment of wastes going to landfill.

Directive on Waste (2008/98/EC) or namely ‘EU Waste Management Law’ establishes a legal framework for treating waste in the EU. It is designed to protect the environment and human health by emphasizing the importance of the proper waste management, recovery and recycling techniques to reduce pressure on resources and improve their use. The legislation establishes a waste hierarchy; prevention, re-use, recycling, recovery for other purposes such as energy and disposal. It confirms the ‘polluter pays principle’ whereby the original waste producer must pay for the costs of waste management. [27, 28]

It also introduces the concept of ‘Extended Producer Responsibility’. This may include an onus on manufacturers to accept and dispose of products returned after use. Producers or holders of waste must treat it themselves or have it handled by an officially recognized operator. They require a permit and are inspected periodically. The waste management must be carried out without any risk to water, air, soil, plants or animals, without causing a nuisance through noise or smells, or harming the countryside or places of special interest. Competent national authorities must establish the waste management plans and waste prevention programmes. [27, 28]

The Directive on the Packaging and Packaging Waste (1994/62/EC) is the most important legislation in the EU which sets out the EU’s rules on managing packaging and packaging waste and led to a significant increase in the recycling of plastics packaging products. [29]

Directive (EU) 2018/852 amends Directive (1994/62/EC) and contains updated measures designed to prevent the production of packaging waste and to promote the reuse, recycling and other forms of recovering of packaging waste instead of its final disposal, thus contributing to the transition towards a circular economy. Directive (EU) 2018/852 has applied since 4 July 2018 and had to become law in the EU countries by 5 July 2020. [30]

According to these directives, ‘the EU countries must take measures such as national programmes, incentives through extended producer responsibility schemes and other economic instruments, to prevent the generation of packaging waste and to minimize the environmental impact of packaging. Besides the EU countries should encourage increasing the share of reusable packaging without compromising food safety. In order to do so, they have to define their deposit-return schemes, targets, economic incentives, minimum percentages of reusable packaging placed on the market for each type of packaging’. [27]

In addition, the EU countries must also take the necessary actions to meet the certain recycling targets which vary depending on a packaging material. According to the Directive on the Packaging and Packaging Waste below targets have to be achieved; [27, 30]

- ✓ By 31 December 2025, at least 65% by weight of all packaging must be recycled. The recycling targets for each material are;

  - 50% of plastic
  - 25% of wood
  - 70% of ferrous metals
  - 50% of aluminum
  - 70% of glass, and
  - 75% of paper and cardboard

- ✓ By 31 December 2030, at least 70% of packaging must be recycled. This includes;

  - 55% of plastic
  - 30% of wood
  - 80% of ferrous metals
  - 60% of aluminum
  - 75% of glass and
  - 85% of paper and cardboard

Besides, the EU countries must ensure that the packaging placed on the market meets the essential requirements contained of the directive; [27, 30]

- ✓ to limit the weight and volume of packaging to a minimum in order to meet the required level of safety, hygiene and acceptability for consumers
- ✓ to reduce the content of hazardous substances and materials in the packaging material and its components
- ✓ to design reusable or recoverable packaging

The EU countries should ensure that systems are set up to provide for the return and/or collection of used packaging and/or packaging waste, as well as the reuse or recovery including recycling of the packaging and/or packaging waste collected. [30]

'By 2025, the EU countries should ensure that producer responsibility schemes are established for all packaging. Extended Producer Responsibility (EPR) schemes provide for the return and/or collection of used packaging and/or packaging waste and its channeling to the most appropriate waste management option, as well as for reuse or recycling of the collected packaging and packaging waste. The schemes should help incentivize packaging that is designed, produced and commercialized in a way that allows its reuse or recovery and that has minimal impact on the environment'. [27, 30]

The Directive (EU) 2015/720 also amends the Directive (1994/62/EC) regarding to reducing the consumption of lightweight plastic carrier bags as it does not contain specific measures for lightweight plastic carrier bags. The EU countries must take measures to reduce the consumption of lightweight plastic carrier bags as they have a harmful impact on the environment. These may include national reduction targets, restrictions on their use or financial measures such as charging for them. According to this Directive; [31]

✓ Maximum annual consumption level should be;

- 90 lightweight plastic carrier bags per person by the end of 2019 (a 50 % reduction compared to 2010) and
- 40 lightweight plastic carrier bags per person by the end of 2025 (an 80 % reduction compared to 2010)

✓ By the end of 2018, lightweight plastic carrier bags are not provided free of charge at the point of sale of goods or products.

✓ Very lightweight plastic carrier bags (i.e. with wall thickness below 15 microns) which are mainly used for the packaging of loose fruits and vegetables may be excluded from the above 2 measures.

- ✓ From 27 May 2018, the EU countries must report the annual consumption of lightweight plastic carrier bags to the European Commission.

The 'Regulation (EU) on Plastic Materials and Articles Intended to Come into Contact with Food' introduces migration limits for the substances used in such packaging and lays down conditions for their use to ensure food safety. It sets out the requirements for the manufacture and marketing of plastic materials and articles intended to come into contact with food. These requirements supplement the general rules laid down in Regulation (EC) No 1935/2004 on materials and articles used for food packaging. [27, 32]

Plastic waste may be contaminated by substances from the previous use of the plastics or by contact with non-food grade plastic. Thus, an adequate process to remove possible contamination is necessary to control the safety of the final product. Regulation (EC) on Recycled Plastic Materials and Articles Intended to Come into Contact with Foods (282/2008) sets out specific measures for recycled plastic materials and articles. This Regulation covers the use of recycled plastic materials and articles which come directly into contact with food. The materials and articles covered here are also subject to Regulation (EU) No 10/2011 on plastic materials intended for food packaging. [27, 33]

The Regulation on the EU Waste Statistics (2150/2002) permits the gathering of regular and comparable data on waste in EU countries and their transmission to Eurostat, the EU's statistics office. The statistics collected allow the EU waste policy implementation to be monitored and evaluated. The EU countries must transmit the statistical results (including confidential data) to Eurostat within 18 months of the end of the reference periods. And every 3 years, the Commission reports to the European Parliament and Council on the statistics prepared under this regulation, their quality and the burden on businesses. [27, 34]

There are many different ways of disposing of waste. Burying it in the ground, known as landfilling, is the least sustainable and environmentally friendly. And so, it must be kept to the absolute minimum. Council Directive on the Landfill of Waste (1999/31/EC) aims to prevent, or reduce as much as possible, any negative impact from landfilling on surface water,

groundwater, soil, air or human health. The EU governments must implement their national strategies to progressively reduce the amount of biodegradable waste sent to landfills. [27, 35]

In addition to all mentioned regulations, a new Directive to ban the ‘Single Use of Plastics’ by 2021 in the EU, has approved by the European Parliament in March 2019. That is a very important step as it is an essential element of the Commission's ‘Circular Economy Action Plan’ which will accelerate the use of sustainable alternatives. The new law will ban the following items such as single-use plastic cutlery (chopsticks, forks, knives and spoons), single-use plastic plates, plastic straws, cotton bud sticks made of plastic, polystyrene cups, and plastic balloon sticks. [36]

Under the new law, the EU will require Member States to achieve a 77% collection target for plastic bottles by 2025 and 90% by 2029. The law will also require plastic bottles to contain at least 25% recycled content by 2025 and 30 percent recycled content by 2030. [36]

4. DISCUSSION

The collected information related to the Turkish and the EU plastic packagings waste management systems and regulations will be compared during the discussion part. To start, it has to be mentioned that the obtained data about Turkey and the EU differ from each other, in terms of their providers, their up-to-dateness and the particulars of the information found and thus, their comparison was not easy and sometimes not complete.

Namely, the comparison of Turkey's results with the generalized data of the European Union is not totally correct, as there are differences between the countries of the EU. While some of them show better performances than Turkey in terms of waste management, some of them stay far behind. However, it is not possible to reach the real data of every country separately and so the general EU data has taken as a reference.

Secondly, the data which were used mainly obtained by the Governmental sources and the European Commission, as they are the most reliable and up to date ones. Besides, the resources of Turkish and the European based NGO's are mostly used.

During the first part of the discussion, the plastics and plastics packagings industries in Turkey and the EU have compared. Secondly, the Turkish and the EU's plastics packagings waste management systems and their performances have discussed. The discussion part has completed by the comparison of their related regulations.

4.1 Turkish versus the European Union's Plastics Industries

Turkey is a developing country in terms of population and its economy that shows a faster growing trend than the EU countries in which many production and consumption markets have reached already a saturation point. As of 2019, Turkey's population is almost 83 million which is higher than every Member States countries. In addition to the needs of increasing population, the production and consumption values increase every year due to the governmental policies and mindset of the people.

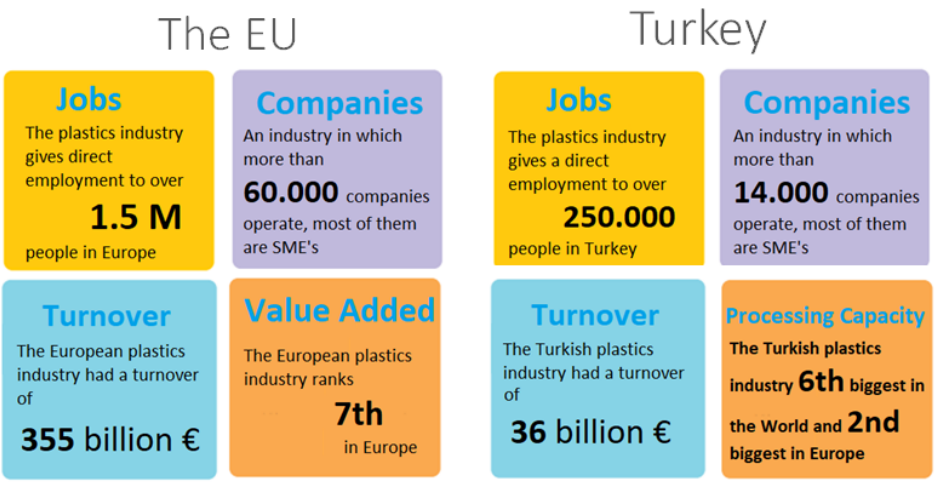

Figure 4.1 Some Key Figures of Plastics Industries of Turkey and the EU (2017) [2, 8]

Turkey's plastics industry is achieving over 10 million tons of production, ~36 billion Euros in revenue, ~4.4 billion Euros in direct exports and an annual rate of growth exceeded 10% over the last decade. Moreover, the processing capacity of Turkish plastics sector is the 6th biggest in the World and the 2nd in Europe. [8] In the meantime, the European plastics industry is having an annual 64,4 million tons of total production, ~350 billion Euros turnover and ~17 billion Euros trade balance in 2017. [2]

The above values firstly say that plastics production market is very important for both Turkey and the EU as it is highly value added and developing market. From the given data, it can be concluded that Turkey's plastics industry is very strong comparing to the EU, as Turkey is achieving alone, 1/6 of the total production amount of the EU and 1/10 by revenue, while the EU data is composed of 28 EU countries plus Norway and Switzerland.

Plastics production capacities and growth rates are mainly depend on the conditions like raw material supplies, regulations, competitiveness and the market demands. [37] By comparing Turkey's current conditions with the EU's, it can be explained why Turkey performs better than the EU countries.

First of all, everyday feedstock supply is getting less stable and polymer prices are getting more volatile. [37] Within this circumstance, it is really hard to keep the end product prices constant while profitability is getting decreases and the competitiveness is getting harder. Of course, if there is an increase or the shortage for the raw materials, it affects Turkey and the EU equally, as both sides have to supply their raw materials from the similar sources. In this case, Turkey has the advantage of being geographically closer to the countries who are the main suppliers of main feedstocks and that will bring a cost advantage in terms of logistics and also the cheaper labor costs still make the Turkish production more competitive comparing to the EU based products. Exclusively, the southern eastern European countries may have a similar advantage of logistics and lower labor costs and becoming more competitive against Turkish producers recently.

As other contributor, the regulations or taxing systems also affects the size of the market. As it has known both in Turkey and the EU, plastics production companies are mainly SME's. Assuring all legislative liabilities is very hard and costly for SME's and so their competitiveness is directly related. In this circumstance, Turkish SME's can be more advantageous than the EU ones, as legislations should be more flexible or their sanctions are less deterrent in Turkey comparing to the EU.

Continuously following up the technological developments is another key factor of being competitive in the market. Considering plastics production and their life cycle, it will create a certain advantage for the countries that are invested on the innovation or technological developments. Of course, the EU can be a pioneer in terms of investing to the new technologies comparing to Turkey. However, Turkish companies are also investing exceedingly to the more technological equipment and machineries to be used in plastics production. According to the press release of PlastEurasia in 2017, during the period of 2012-2016, an average of 821 million dollars of machinery and equipment investment had been realized in the Turkish plastics industry. [38]

The environmental consciousness and the sensitiveness of the societies regarding to the use of plastics and also the new regulations will affect the consumption amounts of plastics and may cause a decrease for the demand. Turkish society can be less sensitive than the EU members

for the environmental issues and problems due to the massive plastics usage yet. Thus, people in Turkey may continue to consume more plastics than the EU's and it will support the domestic plastics production.

All these mentioned factors contribute for Turkish plastics producers being stronger against the European Union competitors. However, both Turkey and the EU have another risk and it is the existence of other non-EU producers, mainly Asian plastics suppliers. To be survived in this competitive market, both the EU and the Turkish plastics producers have to upgrade their products and systems continuously into more efficient and sustainable ones, by investing on new technologies and innovations.

4.2 Turkish versus the European Union's Plastics Waste Management Systems

As the Turkish population and the plastics production rates are expanding, the plastics waste problem is getting bigger every day and so, there is a good opportunity for the entrepreneurs who want to invest on this problem in Turkey nowadays.

In the current conditions, 'Waste Management' and 'Recycling' issues are under the control of Turkish Ministry of Environment and Urbanization (MoEU). While the sole responsibility for the management of municipal waste falls on the municipalities, the industry (producers or suppliers) is also responsible for the collection and recycling of packaging waste they have created/released to the market.

As of today in Turkey, still big amount of recyclable waste is going to landfill due to the inefficient management of the collection and separation steps. According to the Guardian news, in 2016 only 9.8% of the municipal waste sent to recycling centers, with the rest stored in landfills. [39] According to the current legislation, Turkish municipalities are responsible to establish their own waste management systems however; most of them do not have an adequate infrastructure to collect recyclable wastes separately, or temporary landfills to separate and store or to transfer them to the recycling facilities. Generally, limited numbers of municipalities are able to ensure the separation of recyclable waste at source and by the help of authorized institutions.

On the other hand, the situation in the EU is not that different than Turkey. According to the European Commission's 'European Strategy for Plastics' report, during the last decade, almost 50% of the plastics waste collected in the EU were exported to other countries for a treatment due to the insufficient waste management infrastructure of the EU countries, including the collection and separation of the waste, and insufficient number of recycling plants to treat all plastics waste produced in the region. [1]

It also has to be mentioned that every European Union country has a different infrastructure capacity, logistics system and waste management practices because of the different technical, economic and social reasons. Thus, to generalize and say 'The waste management system of the EU does not sufficient' is not right of course as there are many countries in the EU leading the world by their exemplary waste management systems. However, if we consider the EU as a unite system, we may conclude that the primary need for Turkey and the EU is to establish more efficient collection and separation systems.

On the other hand, if we compare the current appliances of the plastics waste management system of Turkey within the EU, it can be said that the biggest difference between their systems is their 'Collection and Separation' methods of plastics packaging wastes.

Within the EU, 18 Member States collect plastics via door-to-door systems. Among these countries only 4 of them collect plastics as a separate fraction but all others co-mingle plastics with one or more fractions. 6 Member States collect plastics via bring-points. And 4 Member States do not collect plastic separately from residual waste. [25]

If we consider Turkey, the door-to-door and bring-points systems are not common methods yet to collect and separate plastics from municipal waste. These systems apply better for other types of waste such as paper, glass or battery, and especially from the industrial or institutional sources. However in terms of the post-consumer waste, municipalities still cannot collect and separate plastics recyclates via these methods efficiently.

This problem provided a job opportunity for individual persons in Turkey (called street collectors) who collect different recyclable materials from the streets or from the garbage containers to sell them to the recycling facilities. And this method became the most common collection and separation of recyclable waste in the first source method in Turkey since a long

time. According to the information given by Mr. Recep Karaman, head of the street waste collectors association of Turkey to the Guardian news, street collectors are collecting the 80% of the waste from the streets. And there are 500,000 street collectors around Turkey. [39]

On the other hand, it is not known if there is a similar application along the EU countries where plastics waste are collected and separated by street collectors.

Figure 4.2 Street Waste Collector Pictures from Turkey

Source: www.google.com/images

Recently within the new regulations, the Turkish government is trying to stop this unregistered collection and obliged them to have licenses to work. That kind of collection and separation activities on the streets are the source of income for thousands of people and their help for the recycling economy cannot be underestimated. However, this unregistered businesses, negatively affects the waste management system that wanted to be established by the MoEU and so the Ministry is trying to keep them under control.

Apart from these methods, a growing number of municipalities in Europe are deploying ‘polluter pays’ or ‘pay-as-you-throw’ schemes that provide strong incentives for the waste prevention and for a correct separation of waste. [1] These principles make the producers/citizens of the waste financially responsible for the collection and treatment of the waste produced.

The current EU legislations have brought a responsibility for the producers of recyclable goods which is called ‘Extended Producer Responsibility (EPR)’ or ‘polluter pays’. [28] Even though, all Member States have to assign responsibility to producers for meeting recycling

targets, practices differ in every Member States in terms of how responsibilities and costs are allocated between the responsibles.

'Extended Producer Responsibility' is also applicable in Turkey, apart from the municipalities, the industry (packaging producers or importers) is responsible for the collection and recycling of the packing waste they have created/released to the market. They can manage this responsibility on their own or by the help of an authorized organization. Additionally, they have to inform the MoEU, by using an electronic 'Packaging Information System' about their packaging production, export, import amounts and their usage areas, as well as the recovery rates every year. And this information is used by the municipalities to prepare their yearly waste management plans and after, the MoEU used this data to prepare Turkey's 'National Waste Management' plans in every 5 years. [14]

On the other hand, the EU countries must transmit their packaging waste release and recovery results to the Eurostat within 18 months of the end of the reference period. And every 3 years, the European Commission reports to the European Parliament and Council about their statistics prepared according to these data given. According to the EU 'Waste Management Law' and other directives, the EU countries also must prepare their 'National Waste Management Plans' and 'Waste prevention programmes'. [35]

In addition to their waste management approaches, if we take a look their latest plastics packaging waste management performances;

According to the 'Packaging and Packaging Waste Statistics 2017' report prepared by MoEU, Turkey was releasing ~915 tons of plastics packaging in to the market in total and from that amount ~497 tons of them had been recovered. That is equal to 54% recovering rate and which is exactly the same number with the recovery target given by the law for 2017.

At this point it is important to mention that before the Turkish 'Regulation on the Management of Packaging Waste' was amended in 2017, 'Recycling' word was not used. Instead only 'Recovery' word was used to define the targets. But within the renewal of regulation, 'Recycling' word started to be used to define the yearly targets for 2018 and later.

It looks there was a confusion between how they are named ‘Recovery’ and ‘Recycling’ exactly. However, the target rates did not change and they are still 54% according to both old and new versions (for 2017 and 2018).

On the other hand, the current EU directive and the results use only ‘Recycling’ name for the plastics packaging waste management targets and values.

Apart from that confusion, there is another issue regarding to Turkish data that have to be considered. First of all, except the reports prepared by MoEU, there is no other source to double check if the given values regarding to the recycling rates of plastics are correct. Normally, the TÜİK (Turkish Statistical Institute) shares data and statistics regarding to waste in general. However, these statistics do not include any plastics packaging waste treatment data separately. It has said that the recycling/recovery rates are calculated according to the information that the MoEU gets from the online system they have established. As it has mentioned before, the plastics producers/releasers have to inform the MoEU every year regarding to the products they released and the recovered/recycled. And the MoEU prepares its reports every year accordingly. As the publisher is the Ministry of Turkey, the accuracy of the data given must be correct of course. But, it would be great if all recycling/recovery data related to plastics packaging waste could be reached also from TÜİK or from another source.

Figure 4.3 Turkey’s Plastics Packaging Waste Management Performance (2017) [14, 19]

In 2016, the EU was recycling 40,8% of the 16,7 tons of plastics packaging waste they had collected. In the meantime, 20.4% of these plastics packaging waste were landfilled while 38.8% of them used for energy recovery. [2] Along this information, the most interesting data is the target recycling ratio of plastics packaging waste was only 22.5% for the EU in 2016. [30] Comparing to this target, the EU average was 40,8% and much higher than the obliged ratio by law. In 2018, the 'Plastic Packaging and Packaging Waste Directive' of the EU was amended, and the new recycling targets will be 50% by 2025 and 55% by 2030 for plastics packaging waste for the EU. [30]

Figure 4.4 The EU's Plastics Packaging Waste Management Performance (2016) [2, 30]

At this point, it also has to be mentioned that the latest data that could be reached for Turkey belongs to the 2017 while for the EU it belongs to 2016. So, the comparison has done by considering this one year time difference.

Among these results, the most remarkable one is the difference between the plastic packaging recycling targets of Turkey (52% for 2016, 54% for 2017 and 55% >2020) [19] and the EU (22.5% for 2016, 50% for 2025 and 55% by 2030). [30] Turkey was amending its regulation in 2017 and the target rates were already higher than 50%, on the other hand the EU was amending its related regulation in 2018 and the new targets will be valid in 2025. Until this time 22.5% target will be valid. This especially shows that the EU is not ready for a remarkable change within the targets as probably the infrastructure and recycling capacities of the European countries are not ready to reach that ratio soon. Of course, it should not be a problem for some leading countries of the EU (such as Czechia, Germany, Netherlands,

Sweden, etc.) but as the law will be valid for 28 countries it should be hard for all of them to ensure as of today. On the other hand, Turkey put 54% target for the same year they amended the regulation and so they should be ready in terms of the capacity and infrastructure to achieve that target.

As it has said, plastic packagings recovery ratio of Turkey in 2017 was 54% while the EU's recycling average was 40.8% in 2016. [2, 14] Among the all European countries, Czechia was the only one which had a recycling rate above the 50%. Germany was following them after with a 50% recycling rate (by including feedstock recovery to the mechanical recovery rate). 15 countries were above the 40.8% average in total while all of the countries were achieving the 22.5% target. [2]

If the Turkey's 54% plastics packaging recycle ratio had compared with the all European Union countries recycling ratios in 2016, Turkey would be ranked 1st in the list before Czechia. However, we are not sure if the given 54% recovery ratio means only 'recycling' rate or including also other methods such as 'incineration for energy recovery' rates.

In that point, the 'landfilling' and 'energy recovery' performances of Turkey and the EU had to be compared also. Even, they are not the best ways to treat plastics packaging waste, 'landfilling' and 'energy recovery' are also parts of 'waste management' systems. From the data in Figure 17, it can be seen that Germany is almost not landfilling plastics. Instead, they are using the plastics which are not recyclate as a source for the 'energy recovery'.

One thing that to be aware of is that the Figure 17 data covers the whole post-consumer plastics not only the plastic packagings. Secondly, from the Turkey's side, there is no information about the 'landfilling' and 'energy recovery' ratios of the post-consumer plastics or plastics packagings neither in the reports of Ministry or any other source which could be reached online. Thus, the second alternative of 'energy recovery' values cannot be compared with the EU ones unfortunately.

From the same Figure 17, it was surprised to see that the most developed European countries like Switzerland, Austria, Netherlands, Denmark, Sweden, Belgium, Finland and Luxemburg, have lower recovery rates but instead they are having a huge energy recovery rates from

plastics incineration. Their landfilling ratios almost zero, and it is because, they have strong national law which is against landfilling.

However, higher energy recovery (incineration) ratios than the recycling, has to be questioned as well. Incineration is a better alternative against landfilling, but still not the best way to treat plastics waste as still losing so valuable natural sources, and the energy obtained after incineration still 3-5 times less comparing the need of energy to produce something from virgin raw material instead of recycled ones. Of course, sometimes it is not easy to recycle plastics especially when they are mixed and not clean, and in these cases it can be more cost efficient to incinerate to recover energy instead of recycling, but this must be very well calculated and the environmental impacts not to be underestimated. [37]

Plastics are particularly attractive for burning, as they're made with petroleum and generate more energy when incinerated than almost any other material. However, burning plastics means also to release harmful dioxins into the air. Even though incineration supporter says such toxics can be filtered out, opponents declare that even the best plants do not filter out all types of toxics. Incineration systems are very expensive to build and to compensate its costs; they have to operate min 40-50 years. So, the countries already invested to these systems cannot stop to burn wastes and invest more for recycling. They even have to import waste to fill their capacities. Thus, this is a big handicap for the countries like Sweden, Denmark or Norway where incineration rates are higher than recycling. [40]

It is also valid for Turkey, as it is very depended on the other countries in terms of energy production, some people in Turkey supports the idea that energy recovery / production from the waste and sees it as a good business opportunity.

To sum up; these scenarios are against also the European Commission's targets about the 'circular economy of plastics' which aims to minimize the waste and to increase the use of products and resources as long as possible. And also that advise recycling above all then incineration or landfilling. If the EU countries continues to increase their incineration capacities than the recycling systems, the recycling targets given for 2025 or 2030, will not be achieved around the EU.

4.3 Turkish versus the European Union's Plastics Waste Management Regulations

In the current situation, most of the EU waste management regulations had been transposed into Turkey's national legislation system as Turkey had to assure them as the EU candidate member. And since the last decade, Turkey has showed a good improvement in terms of the waste management system thanks to the changes made on the legislation system.

The below table provides an overview for the current Turkish and the EU legislations that are related to the plastic packagings waste treatments;

Table 4.1 Turkish vs. the EU Plastics Packaging Waste Management Regulations

The Turkish Regulations	Latest Version	The EU Regulations	Latest Version
The Environmental Law	1983	NA. There is not specific law called Environmental but whole legislations related to the Environmental policies named as Environmental laws	-
Regulation on the Waste Management	2017	Directive on Waste and Repealing Certain Directives (EU Waste Management Law)	2008
Regulation on the Management of Packaging Waste	2017	Directive on the Packaging and Packaging Waste	2018
NA. It has explained as a part of 'Regulation on the Management of Packaging Waste'	-	Directive on Reducing the Consumption of Lightweight Plastic Carrier Bags	2015
NA. There is another regulation called 'Regulation on the Materials and Articles Intended to Come into Contact with Foods' which mentions about the plastics materials and their contact with food.	-	Regulation on Plastic Materials and Articles Intended to Come into Contact with Foods	2011
NA	-	Regulation on Recycled Plastic Materials and Articles Intended to Come into Contact with Foods	2008
Regulation on the Landfill of Waste	2015	Directive on the Landfill of Waste	1999
NA. How to record the waste data explained as a part of 'Regulation on the Management of Packaging Waste'	-	Regulation on the EU Waste Statistics	2002

In Turkey, waste management legislations are organized under these two main legislations; 'The Environmental Law' and 'Regulation on the Waste Management'. On the other hand, 'Directive on Waste and Repealing Certain Directives' or namely 'EU Waste Management Law' establishes a legal framework for treating waste in the EU.

Both Turkish 'Regulation on the Waste Management' and 'The EU Waste Management Law' define proper waste management, recovery and recycling techniques and talk about the waste hierarchy; prevention, re-use, recycling, recovery for other purposes such as energy and disposal. They both also explain the 'Extended Producer Responsibility' principles and also mention about the responsibilities about the waste management plans and waste prevention programmes.

The 'Directive on the Packaging and Packaging Waste' is the most important legislation in the EU which sets out the EU's rules related to packaging waste. This regulation recently amended in 2018 and some important issues and ratios are updated. In the Turkish side, it is called 'Regulation on the Management of Packaging Waste' which has updated also in 2017. Even though their sub-topics are the similar, their main differences are the recycling ratios obliged in Turkey and the EU; at it has said before, for Turkey the plastics recycling ratio target is 54% during 2017-2019 while it will be 55% after 2020. On the other hand, the plastics recycling ratio target will be 22.5% until 2025, between 2025-2030 the target will be 50% and after 2030 it will be 55%. In this scenario, Turkey will have the same target 10 years before the EU and it can accelerate the Turkish recycling market better and sooner than the EU.

On the other hand, both 'packaging waste' legislations give some information about the usage of lightweight plastic career bags such as the usage targets in recent years and also their sales in the market. Given target values about the use of lightweight plastic bags for Turkey and the EU are the same; '90 per person by the end of 2019 and 40 per person by the end of 2025' or 'not to give bags for free since 2019. However, in the EU side, there is an additional directive called 'Directive on Reducing the Consumption of Lightweight Plastic Carrier Bags' which is actually amending directive of the EU's 'Directive on the Packaging and Packaging Waste'. But in Turkish side, there is no separate directive for it.

As another EU directive ‘Council Directive on the Landfill of Waste’ that aims to prevent, or reduce as much as possible, any negative impact from landfilling on surface water, groundwater, soil, air or human health. Its similar Turkish version also called ‘Regulation on the Landfill of Waste’ that has updated in 2015.

The EU has two other legislations which Turkey does not have them yet. The first one is called ‘Regulation on Plastic Materials and Articles Intended to Come into Contact with Food’ which sets out the requirements for the manufacture and marketing of plastic materials and articles intended to come into contact with food. And the second one is called ‘Regulation on Recycled Plastic Materials and Articles Intended to Come into Contact with Foods’ which covers the use of recycled plastic materials and articles which come directly into contact with food.

On contrast, Turkey has a legislation called ‘Regulation on the Materials and Articles Intended to Come into Contact with Foods’ which is more general comparing to the EU plastic specific ones. In one part of this regulation, it is talked about the plastics that contacts with the food and their obligations. It is also said that the recycled plastics cannot be used in the production of food contact materials, with some exceptions.

The EU has a legislation called ‘Regulation on the EU Waste Statistics’ permits the gathering of regular and comparable data on waste in EU countries and their transmission to EU’s statistics office. And these data will be used by the Commission to prepare a report about their performance of waste management.

In the Turkish side, there is no specific legislation how to define for keeping waste statistics, however in the case of packaging waste, there is an online notification system which is explained in Turkish ‘Regulation on the Management of Packaging Waste’. Additionally, about general waste data, there is another online notification system called ‘Integrated Environment Information System’ that has mentioned in Turkish ‘Regulation on the Waste Management’. These online systems are used to collect the data from the market about the waste produced and how they treated after, and these data are used to prepare waste statistics by the Ministry.

Apart from those, Turkey has some other legislation related to the plastic waste management. For example; as the plastics waste Collection and Separation is the responsibility of Municipalities, the ‘Municipality Law’ and the ‘Metropolitan Municipality Law’ are valid and have to be considered. Or the ‘Regulation on the Environmental Permissions and Licenses’ gives information about procedures and principles to be followed in the process of environmental permits and licenses to be taken in accordance with the Environmental Law. These are somehow national laws for Turkey and of course similar ones may exist for every EU countries, but they also should be managed in the national size and cannot be compared with the Turkish legislation one by one.

And finally, there is very important step in the EU side regarding to the plastics waste management and it’s the release of new directive to ban the ‘Single Use of Plastics’ by 2021 in the EU that has approved by the European Parliament in March 2019. That is a very important step as it is an essential element of the Commission's ‘Circular Economy Action Plan’ which will stimulate the production and use of sustainable alternatives to solve plastics problem.

In the Turkish side, there is no legislation which will ban the use of singles plastics soon, but Turkey has also started a new project called ‘Zero Waste Movement’ and already released a draft Regulation called ‘Regulation on the Zero Waste’ in 2019 that looks promising for the near future.

5. CONCLUSION

By collecting and comparing all the information and data obtained during this research, it was aimed to analyze the adequacy of current Turkish plastic packaging waste management system and regulations and as well as the European Union's.

First of all, it is legitimate to say that plastics production sector is very important for both Turkey and the EU as it is highly value added and developing. According to the information obtained, it can be concluded that Turkey's plastics industry is very strong comparing to the EU, as Turkey is achieving alone, 1/6 of the total production amount of the EU and 1/10 of the EU in terms of revenue. In this point, Turkey's higher plastic production ratios can be explained by its certain advantages such as being geographically closer to main feedstocks, developing economy, having cheaper labor costs, less regulated and environmentally less sensitive comparing to the EU. All these factors contribute Turkish plastics producers for being stronger against the European Union competitors. However, the existence of other non-EU producers, mainly Asian plastics suppliers, is still a big threat for both Turkish and the EU producers. To be survived in this competition, both the EU and Turkish plastics producers have to invest continuously for more sustainable products and technologies.

As a second part of this research, detailed information about the Turkish and the EU plastics waste management systems were collected. Even though, both systems are well constructed (Turkish one has also established according to the EU model), their practices are not adequate and have to be improved urgently. According to the European Commission's 'European Strategy for Plastics' report, during the last decade, almost 50% of the plastics waste collected in the EU were exported to other countries for a treatment due to the insufficient waste management infrastructure of the EU countries, including the collection and separation of the waste, and insufficient number of recycling plants. On the other hand, still big amount of recyclable waste is going to landfill in Turkey due to the inefficient management of the collection and separation steps. According to the Guardian news, in 2016 only 9.8% of the municipal waste sent to recycling centers, with the rest stored in landfills.

In the EU case, there are many countries in the EU leading the world by their exemplary waste management systems so; it is not correct to generalize the problem for the whole the

EU Member States. However, all the EU targets given by laws are valid for every member states and the ones who have not have the sufficient infrastructure capacity, logistics system or waste management practices, have to be supported.

For the Turkish side, even though the MSW recycling ratios were too low, the situation looks promising in terms of 'plastics packaging' waste management performance. According to the Ministry data, 54% of the plastic packagings released to the market in 2017 were recovered and that was exactly the same with the recovery target given (54%) by Turkish law for 2017.

On the other side, the EU's recycling target for plastic packagings was only 22.5% and the EU Member states were realizing 40,8% of recycling by average in 2016 (the most recent data). Among the all European countries, Czechia was the only one which had a recycling rate above the 50%. Germany was following them after with a 50% recycling rate. 15 countries were above the 40.8% average in total while all of the countries were achieving the 22.5% target. If the Turkey's 54% plastics packaging recover ratio had compared with the all European Union countries recycling ratios, Turkey would be ranked 1st in the list before Czechia. However, it not known if the given 54% recovery ratio means only 'recycling' rate or covering also other methods such as 'incineration for energy recovery' ratio. Actually, 'Recycling' word was not used in previous Turkish regulation also to define the targets but instead only 'Recovery' word was used. But within the renewal of regulation in 2017, 'Recycling' word started to be used to define the yearly targets for 2018 and later. So, it was bit confusion in terms of definitions.

Among these results, the most remarkable one was the difference between the plastic packaging recycling targets of Turkey and the EU. Turkey was amending its regulation in 2017 and the target rates were already higher than 50%, on the other hand the EU was amending its related regulation in 2018 and the new targets (50% for 2025 and 55% by 2030) will be valid in 2025. Until this time 22.5% target will be still applicable. It can be interpreted as the EU is not ready for a notable change within the targets as probably the infrastructure and recycling capacities of the some European countries are not ready to reach these ratios soon. On the other hand, Turkey's recycling target was 54% for 2017 so they should be ready to reach for it.

When a waste management system is evaluated, even though the recycling is the most efficient way to treat plastics waste, there are other ways such as ‘landfilling’ or ‘incineration’ that have to be considered also. However, as it was not possible to reach Turkish data for the landfilling or incineration for plastics waste and so its comparison with the EU data was not possible.

As the final step of the research, plastic waste management related legislations of Turkey and the EU were investigated. In the current situation, most of the EU waste management regulations had been transposed into Turkey’s national legislation system as Turkey had to assure them as the EU candidate member. Only, some directives are missing in the Turkish side. For instance, Turkey does not have a separate Directive related to lightweight plastics bags or related to the plastics which will be used in food contacts. Even though, Turkey does not have a specific regulation for each, these topics are covered under main plastic packaging and waste management regulations.

More importantly, in the EU side, the release of new directive to ban the ‘Single Use of Plastics’ by 2021, was a very important step for achieving the EU’s ‘Circular Economy Action Plan’ which will stimulate the production and use of sustainable alternatives to solve plastics problem.

In the Turkish side, there is no legislation which will ban the use of singles plastics soon, but Turkey has also started a new project called ‘Zero Waste Movement’ and already released a draft Regulation called ‘Regulation on the Zero Waste’ in 2019 that looks promising step for achieving a sustainable waste management.

To sum up, by considering all information given it can be concluded that, even though good steps have taken such as the establishment of ‘circular economy of plastics’ or ‘zero waste movement’ models, unfortunately both the current Turkish and the EU’s plastics waste management applications and regulations are not sufficient enough to solve the plastics problem soon.

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