EU Strategy on Plastics in Circular Economy

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Plastics Technology

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Abstract:

The focus of thesis is to analysis and highlight the strategy made by European Union (EU) regarding circular economy. The strategy made by EU had focused in many factors which will have significant impact at present or in future. Mainly EU demands to analyze the significant impact of plastics and its products in circular economy as well as impact in environment, nature, people etc. Most of our economic activities is linear model but with this new reform and ideas, it will transit to circular model. At this present time, whole world had shown so many concerns about its negative impact on our eco-system. So many countries, organization are trying to minimize the effect through different steps and process. The steps may be recycling, reuse, reducing the use of plastics etc. With the help of material flow diagram, flow of raw materials can be obtained. The EU had adopted a framework for monitoring circular economy as a circular economy action plan which keeps track the progress made in economy and provides information towards business and consumers on ongoing developments. EU is funding many projects like Horizon 2020, etc. Due to circular economy action plan, percentage of recycling and the flow of secondary raw materials in the supply chain is increasing thus helping to form a circular model economy.

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Abbreviation

EU: European Union
LDPE: Low density polyethylene
HDPE-: High density polyethylene
PET: Polyethylene terephthalate
ERDF: European Regional Development Fund
ESF: European Social Fund
CF: Cohesion Fund
EAFRD: European Agriculture Fund for Rural Development
EMFF: European Maritime and Fisheries Fund
OECD: Economic Co-operation and Development (OECD)

GDP: Gross Domestic Product

SMEs: Small medium-sized enterprises

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1 INTRODUCTION

1.1 History and backgroud

Plastics can be defined as a very wide range of synthetic and semi-synthetic materials or natural polymers which has very good malleability. Plastics are made up of very long chain of ploymers due to which its has very high molecular weight. Due to this malleability characteristics , plastics and plastic products are used in very wide range of appilcation in day to day life. Plastics and plastic products had make life easy so it is very intertwisted into our economy as well. Every products made today had some involvement of plastics because they are either cheap, durable, light weight and had a perfect characteristics for that product.

Nowadays, every small or big production companies have wide range of use of plastics. Even companies which are producing other products are using plastics in some form like packaging etc. Since from production of plastics to its uses, either in industrial purpose or in household purpose or to its management after uses , a very complex circular economy lies there, where millions of people around the world are directly or indirectly involve in it. Due to its vast uses in different fields, it has helped to rise the standard of living human but also had cause many hamrful effects. So to overcome from all of this, In 2015, EU had made very special stretagy to counter it. From This stretagy, EU wants to increase value chain in the circular economy with different methods as well as want to ensure the goal of recycle of all plastics by 2030.

The EU can play very vitol role for transition to the plastic of the future, since the new strategy opens many options and foundation for the new circular economy, new design and idea for production of plastics and plastic products can compile for recycling, repair, resuse, use of bio-based products for more sustainable for environment. It helps to delivery high added value and prosperity as well help to boast innovation in EU. Innovation and high added value are linked with each other for which good platform is need for innovation. To get success for this strategy, EU needs full commitments for action from Key players from EU level and well as private sector with national and regional authorities, cities and citizens. Making internaionl engagement will help to boost change outside europe. With all this effort , EU is achieving of sustainable development goals and Paris agreement upto 2030 seems vaiable.

1.2 Plastics in General

Plastics consists of long chain of monomers or repeated chain of monomers which has very good malleability. Monomers are building block which are repeated throughout the plastics and plastics are generally derived from organic materials like coal, natural gas, crude oil, salt, sand and other possible sources. Plastics can also be made from secondary materials which are produced through recycling plastics waste. Bio-based products are partly obtained from materials of biological origin like plants etc.

Plastics can be divided into two groups:

- Thermosets
- Thermoplastics.

1.2.1 Thermosets

Thermosets are those types of plastics which became hard when they are mixed together with a hardener, it cannot be remolded or reheated to obtain their initial phase. It is hard and brittle, and they are very easy to use together with stiffening materials like fibers. In thermoset plastics, polymers are in cross-link together which eliminates the risk of the product remelting when heat is applied. It helps to improve the material's mechanical properties, providing enhances chemical resistance, heat resistance and structural integrity. It is very cost-effective, inability to recycle and eco-friendly manufacturing. Phenolic resins, polyester resins and epoxies are some of the examples of thermosets. (Anon., 2017)

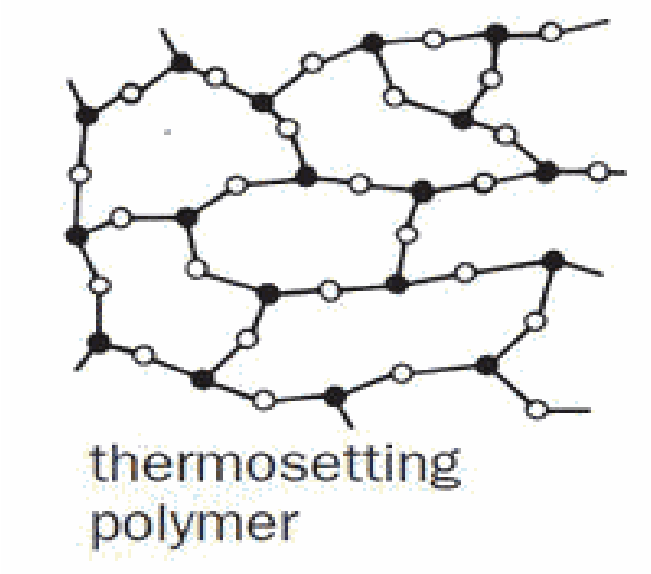

Figure 1: Thermosets (Anon., 2019)

1.2.2 Thermoplastics

Thermoplastics are made of up macromolecules chains without crosslinking between the chains and those type of polymers can be moldable and pliable at a certain elevated temperature. Its characteristics shows that it melts when temperature is added and became harder when it is cooled maintaining its chemical composition same, it has reversible characteristics. It is widely used because it is mechanically recyclable. They are used in many fields like playing sports equipment's, toys, various automobile parts, drinking bottles, food storage containers etc. Examples of thermoplastics are polypropylene, polyethylene, polyvinylchloride, polystyrene, polycarbonate etc. (Anon., 2019)

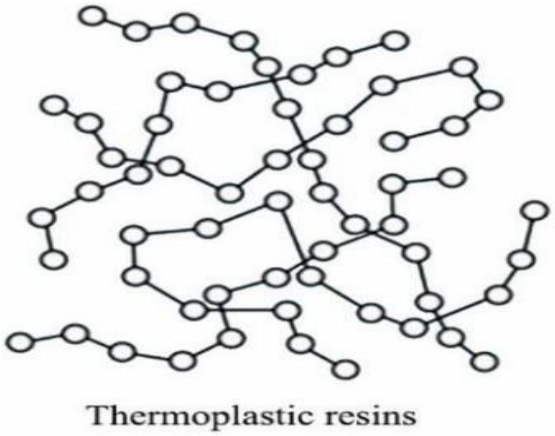

Figure 2: Thermoplastics (Anon., 2019)

1.2.3 Microplastics

Microplastics are also known as small plastic pieces which can be found in any shape and sizes but they are less than five millimeters in length .They are formed after degradation of plastics or intentationally made and are major cause of pollution which is widespread all arcoss the globe. Due to its size, it can enter into environment which is very hazardous for everyone specially, its effect can be seen in marine life.

Figure 3: Microplastics present in toothpaste (Anon., 2015)

There are two types of microplastics which are categorized according to how it is formed or made. The primary microplastics are those whose main sources are cosmetic and personal care products like cleansers, shower gels etc. This types of microplastics can also be made up of by various means like erosion of tire, road marking, city dust etc. The secondary microplastics are formed when large plastics are broken down into smaller pieces due to effect of sun or any other mechanical forces. Microplastic is affecting marine life in such a way that without serious and dedicated steps marine lives can go to extinction. Microplastics are found on many marine organisms from plankton species to whale. The leaking of additives from microplastics had contaminated water sources which can be transferred to food and can have a hazardous effect. (NOAA, 2018)

1.3 Plastics today

Plastics are used for many purposes like packaging, manufacturing different items and parts, electronics, etc. World can't imagine a life without plastics and still didn't have found any alternative for it. Its unique properties had played important role, so every item made today's have certain percentage amount of plastics in it like car had around 15% by weight whereas Boeing Dreamliner consists of 50% weight. The use of plastics is due to having combination of many factors like low cost, durability, high strength to weight ratio and its unique versatility etc.

According to data provided by Plastics Europe, the use of plastics had increased exponentially. In year 1964, the total use of plastics all around the world was around 15 metric tons which reached around 311 metric tons in 2014.

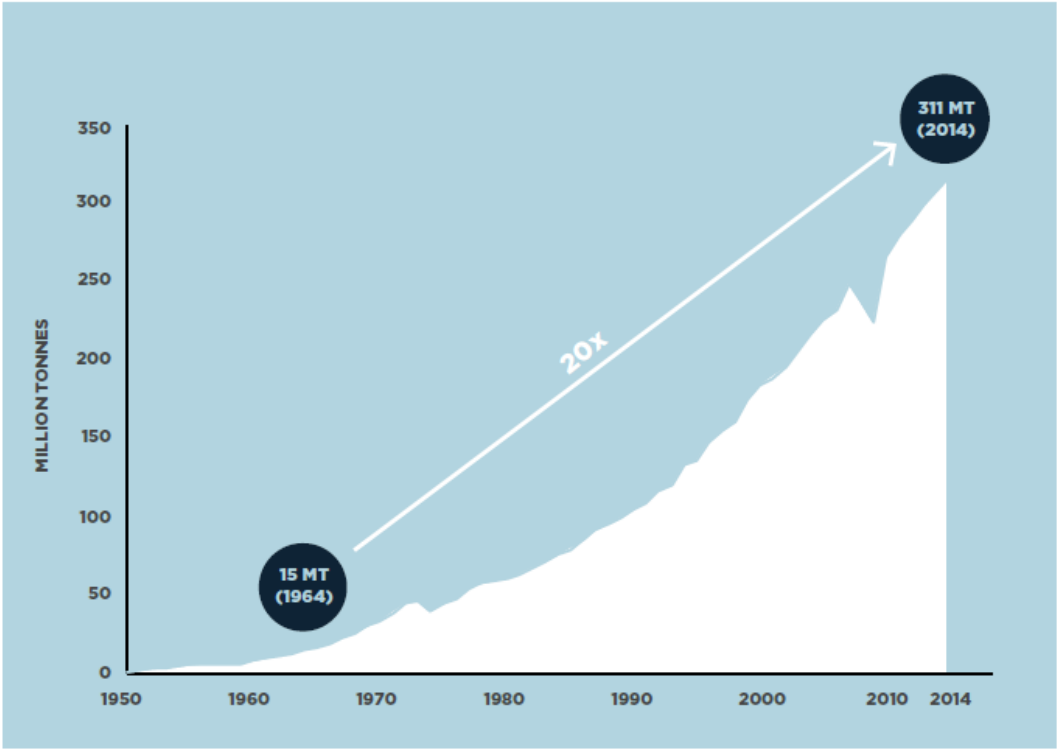

Figure 4: Plastics Consumptions growth from 1950 to 2014 (Ellen MacArthur Foundation, 2016)

Though the population of Europe is low compare to Asia, still it produces same amount of plastics waste. In figure 5, Europe is divided into two parts according to regions, one is Western Europe and other one is Eastern Europe. From figure 5, economy plays very important role for higher in consumption as Western Europe has higher waste production than Eastern Europe.

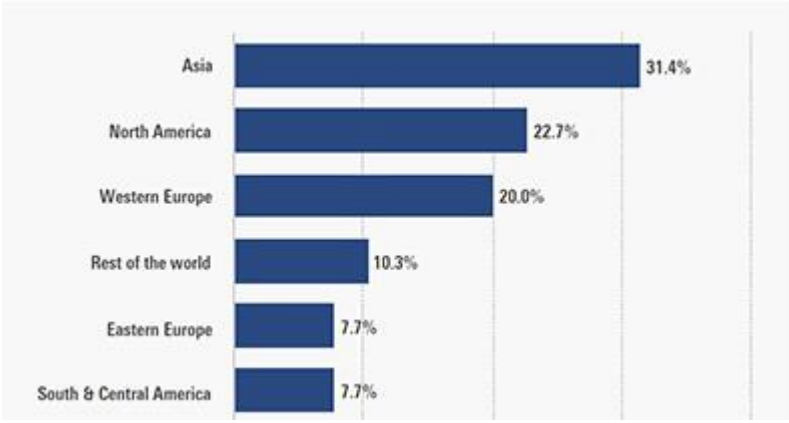

Figure 5: Global rigid plastic packaging consumption, percentage share by geography region on 2017 (Anon., 2017)

In rephrase this to whole world, Europe have also shown exponential growth in plastic consumption, since the purchasing power capacity of European nations are quite high it is obvious to have high consumption of plastics. Consumption of plastics with respect to world is shown in Figure 6, where Europe consume around 52 million tons of plastics per year.

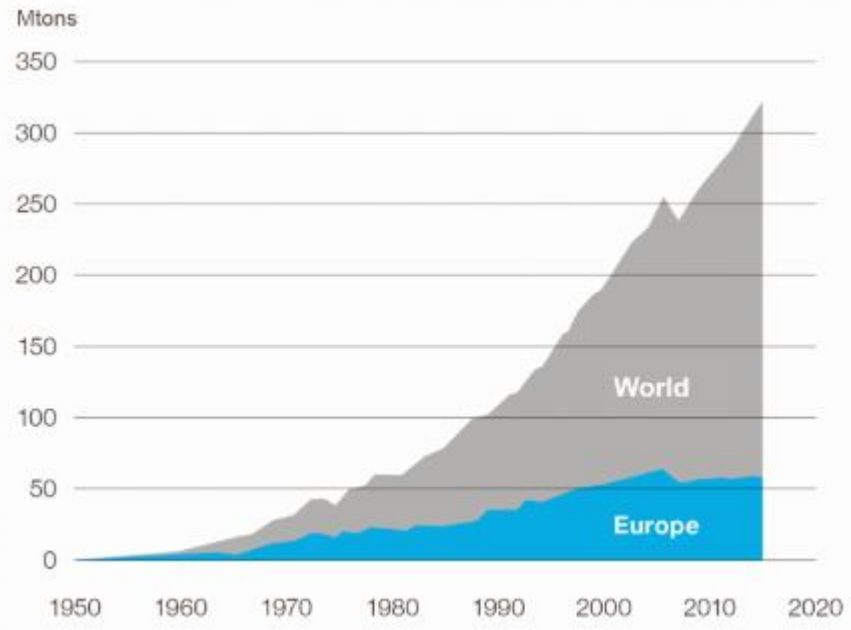

Figure 6: Plastic consumption growth of Europe with respect to World (Anon., 2019)

Since, EU is industrialized in early 20th century, so having higher purchasing power, most of consumption of plastics is used for packaging due to which plastics consumption per capita of each member states is high compared to world average, more consumption means more waste if there is no proper waste management, it will create problem . Ireland accounts the highest number of plastics waste producer per capita of 58 kg whereas Finland produces waste of 22 kg per capita and Croatia produces just 13kg per capita which is lowest in Europe. This kind of differences between each EU member states is due to having different purchasing power, waste management system etc. which can be seen in Figure 7. (Wecker, 2018)

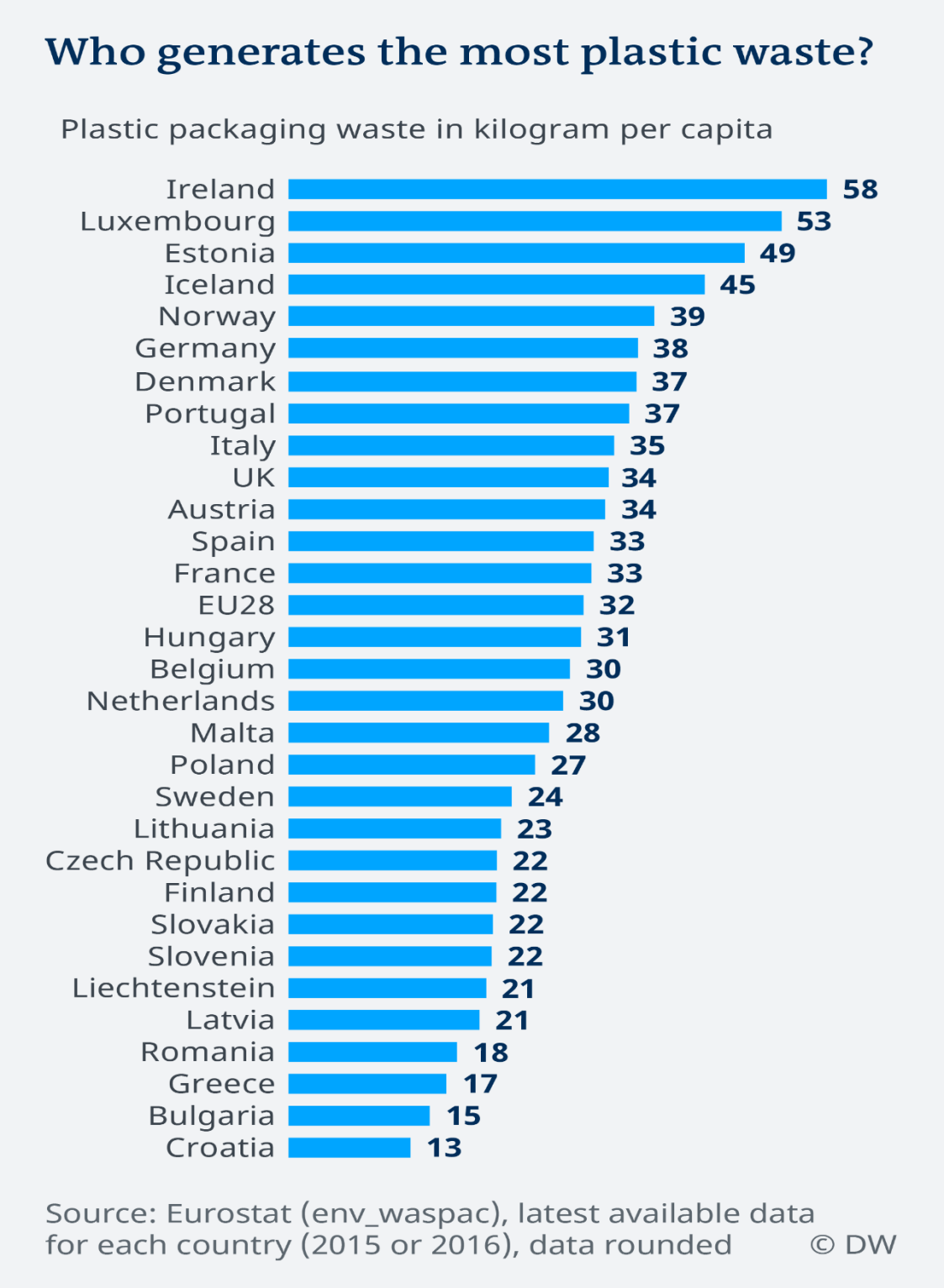

Figure 7: Average EU plastic waste produced per inhabitant on 2015 or 2016 (Wecker, 2018)

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There are many types of plastics waste produced by its polymer types daily but most of the waste belongs to few categories like LDPE, HDPE, PP etc. which is shown in figure 8. Packaging is the main source of plastics waste and it includes waste like bags, sacks and wraps, PET bottles and jars, HDPE natural bottles and other containers.

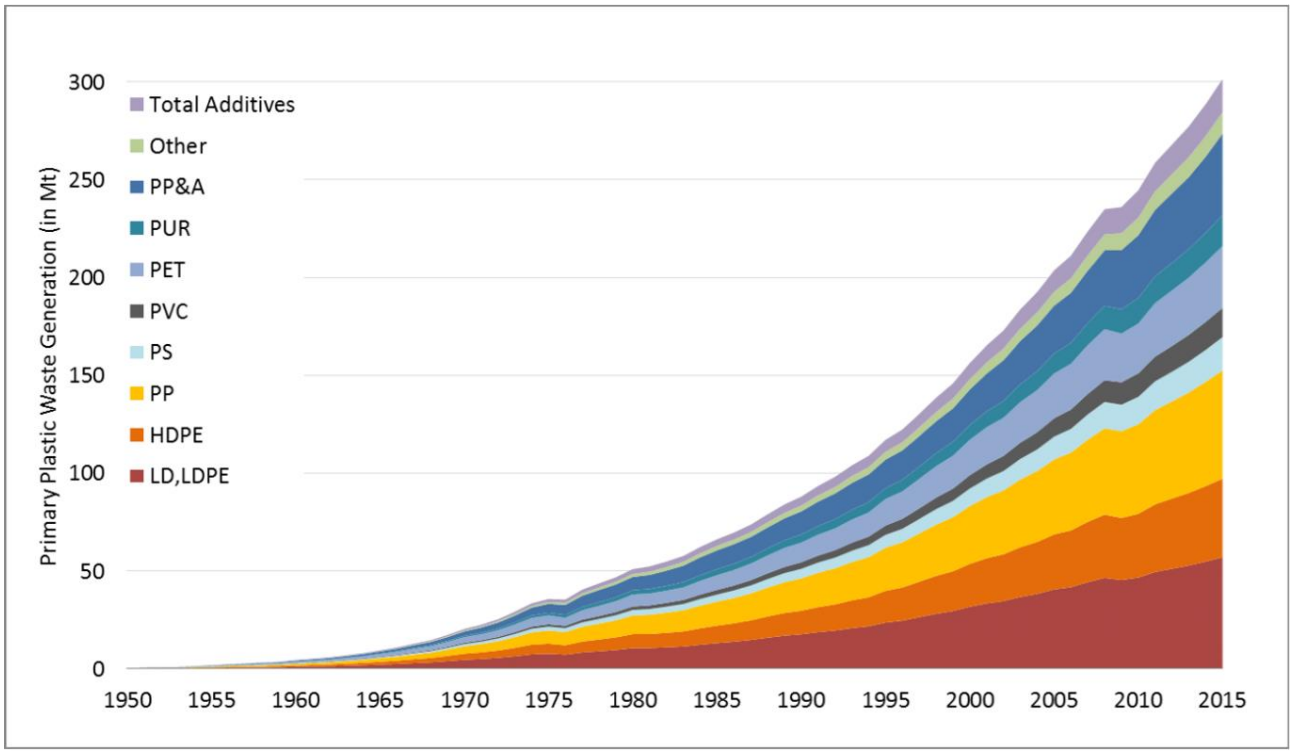

Figure 8: Waste generated by polymer types in million tons in years (Wallace, 2017)

1.4 Plastics consumption in EU

In Europe, three sectors of industries consume most of the plastics which accounts around 75% of total. Packaging industry contributes the maximum which consumes around 39.4% of plastics. Packaging materials had limited lifetime and economic value. After packaging industries, most of plastics are used in car industries and construction industries contributing around 8.3% and 20.5% respectively. Remaining 25% of plastics are consumed by many different industries like electronics manufacturer etc.

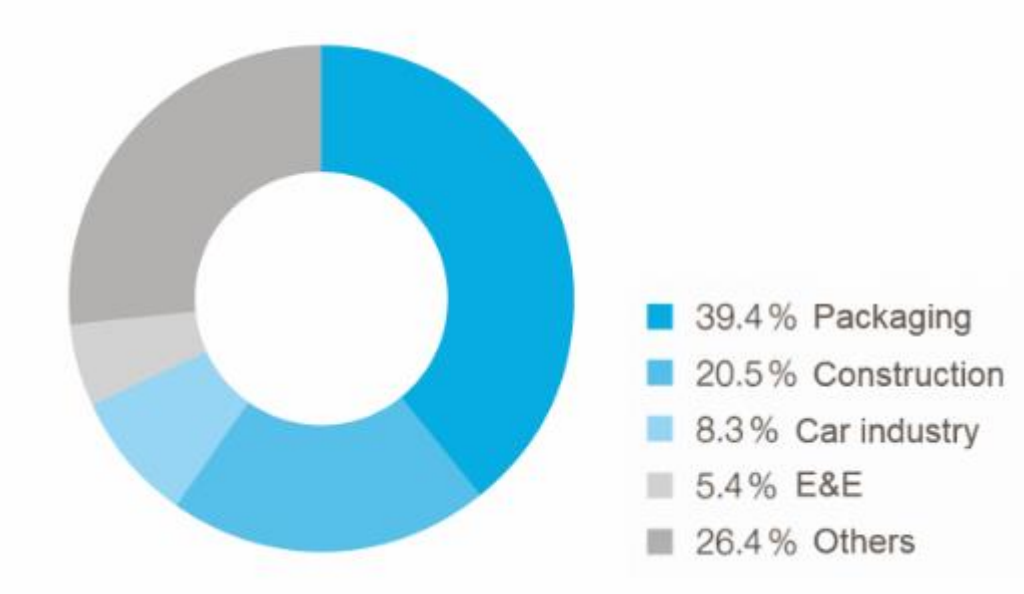

Figure 9: Consumption of plastics according to industries (Anon., 2019)

1.5 Importance of European plastic industries

European Union consists of highly industrialized states which contributes 21.8% share of world's economy in 2016 whereas GDP per capita is around €29000. European Union is also one of the leading exporters as well as importer of goods and services holding 15% share in global values. The consumption of plastics has reached 100 kg in Western Europe and it is expected to grow more, till now more than 60,000 companies are operating inside EU,1.5 million people are directly employed by plastics related fields which have turnover of nearly 350 billion Euros per year. It has also helped to make positive trade balance with nations outside of European Union. Having such a good impact on economy, EU is targeting to be forefront on effort to support environmentally sound waste

management and the promotion of circular economy. In year 2014, around 57 million tons of primary plastics were produced in EU annually only 0.5% to 1% of them were bio-based plastics which employed 23,000 people. (European commission, 2018)

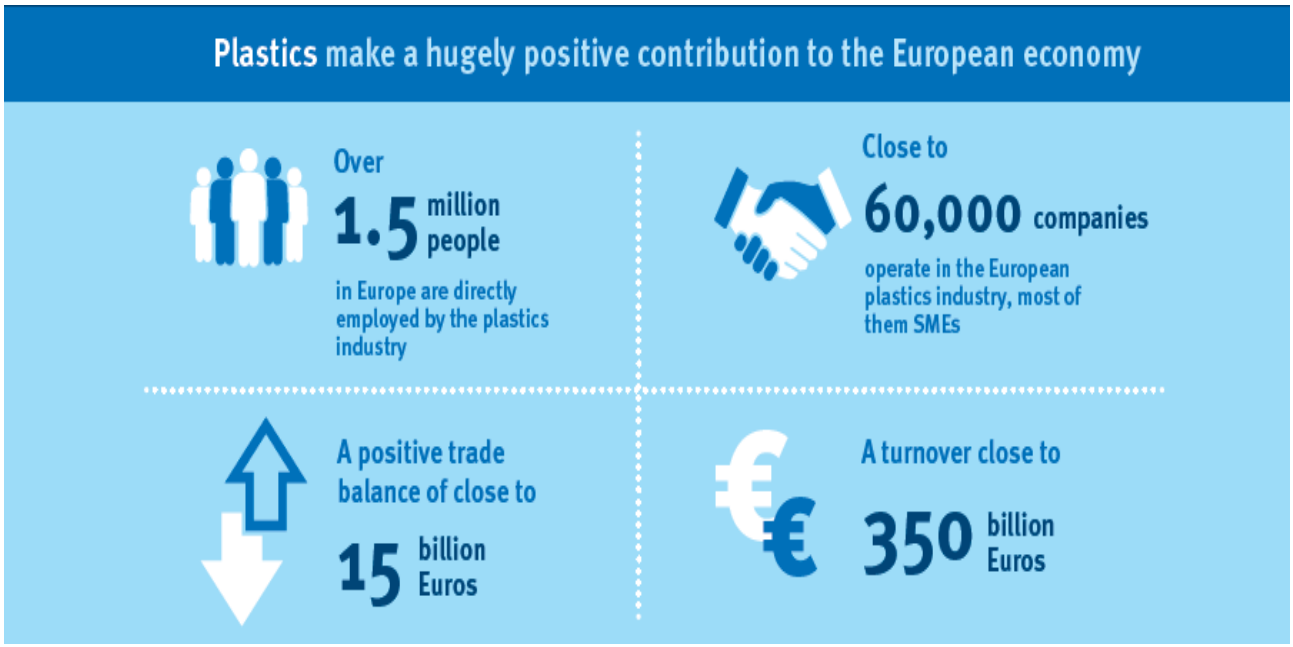

Figure 10:Plastic Economy inside EU. (PlasticsEurope, 2017-2018)

2 VISION FOR NEW PLASTIC ECONOMY

"A circular economy could increase the efficiency of primary resource consumption in Europe and the world. By conserving materials embodied in high value products or returning wastes to the economy as high-quality secondary raw materials, a circular economy would reduce the demand for primary raw materials. This would help reduce Europe's dependence on imports, making the procurement chains for many industrial sectors less subject to the price volatility of international commodity markets and supply uncertainty due to scarcity and/or geopolitical factors."

EUROPEAN ENVIRONMENT AGENCY

(Plastics Recycler Europe, 2019)

In future, the cost of resources will be volatile which can affect the future economy of EU, Since the population in EU is increasing day by day and it is estimated that the population in EU will reached up to 510 million people by 2020 (European Environment Agency, 2016), to have a sustainable economy with limited resources, it can create a lot of tensions inside EU states and can reduce the living standard of citizens. So, the current linear model has its limitation. So, to overcome this, a new model which would reflect the needs of today's world is needed. Ellen MacArthur states that the circular economy model offers a sustainable and resilient long-term solution that will run on circular loop and can bring prosperity and safety to the society and the environment.

European Union has made a clear vision about future economy relates to plastics where a smart, innovative and sustainable plastics industry will be developed, and the products produces by these industries fully respect the management process like reuse , recycle and repair thus help in bringing growth and jobs to Europe and helps to cut the dependence on imported fossil fuels and cutting the greenhouse gas emissions. Nearly 60,000 Small and Medium sized enterprises companies are operating inside European Union, which helps to bring trade balance close to 15 billion euros. (Ellen MacArthur Foundation, 2016)

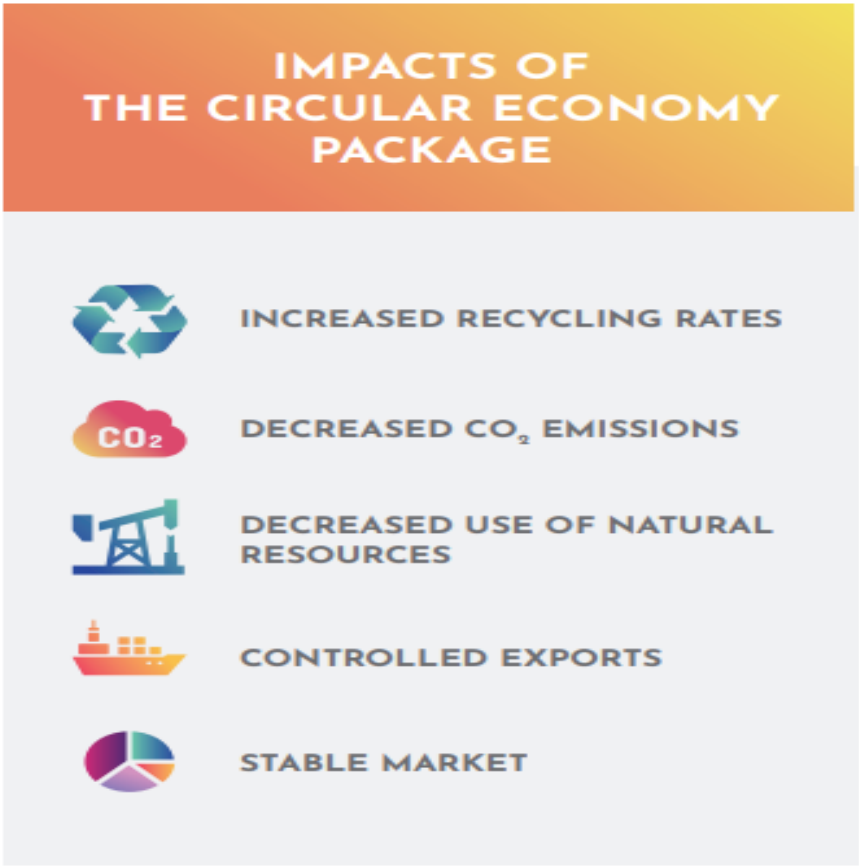

Figure 11: Impact of recycling in circular economy (Commission, 2018)

Some important points which EU wants to implement:

- Helping the plastics waste management by designing plastics and plastics products and making it easy for recycle, reuse, repair and have greater durability.
- By 2030, in EU, making all plastics packaging reusable or recycled in a cost-effective manner.
- By 2030, Modernizing the recycling capacity significantly inside EU.
- Increasing sorting and recycling capacity all around Europe and creating new jobs.
- By 2030, more than 50% plastics waste will be recycled in Europe.
- Increasing the plastics collection and improving separate collection center for plastics.
- Increasing investment in innovation, skill and capacity upscaling.
- Exporting recycled plastics to industries.
- Becoming leaders in technologies related to recycle, reuse and sorting.
- Involving every citizen and making aware to avoid waste and make choice accordingly.
- Incentive and make aware about key benefits so consumers can contribute in transition for better design, new business model, and innovative products which provides more sustainable consumption patterns.
- Creating business opportunity for entrepreneurs and making the need of resolute action on plastics waste as well as new companies emerging can provide circular economy solution.
- Creating effective waste collection and preventing its leakage into environment. Handling litter and ensure it is handled appropriately.
- Reducing sea-based sources activities like ships, fishing and aquaculture thus saving fragile ecosystems.
- Developing innovative solutions to prevent microplastics from reaching the seas, oceans in air, drinking water and in our plates.

  (European commission, 2018)

3 IMPLEMENTING ACTION PLAN ON CIRCULAR ECONOMY

European union is more focused in implementing improving competitiveness and resource efficiency to provide an alternative of more sustainable model to the traditional linear economy. Linear economy means following the path of make, use and then dispose. Today, most of the countries are very dependent on linear economy due to which many plastics waste problem is increasing as well as they

are not able to take the advantages that can be provided by circular economy. Circular economy means make, use and recycle. Circular economy provides environmental sustainability as well as may jobs in future. Plastics had distinct and unique properties like durability, less mass and versality due to which the uses of plastic in increasing exponentially all over the world. To make sure the circular economy will be sustainable on long run, there should be a very good implementation of polices and decisions taking. It should be taken in consideration that the plastics waste doesn't end into landfill or in the environment which can have adverse effects as well as do harm in circular economy. Recycling and reuse of plastics play the major role for circular economy.

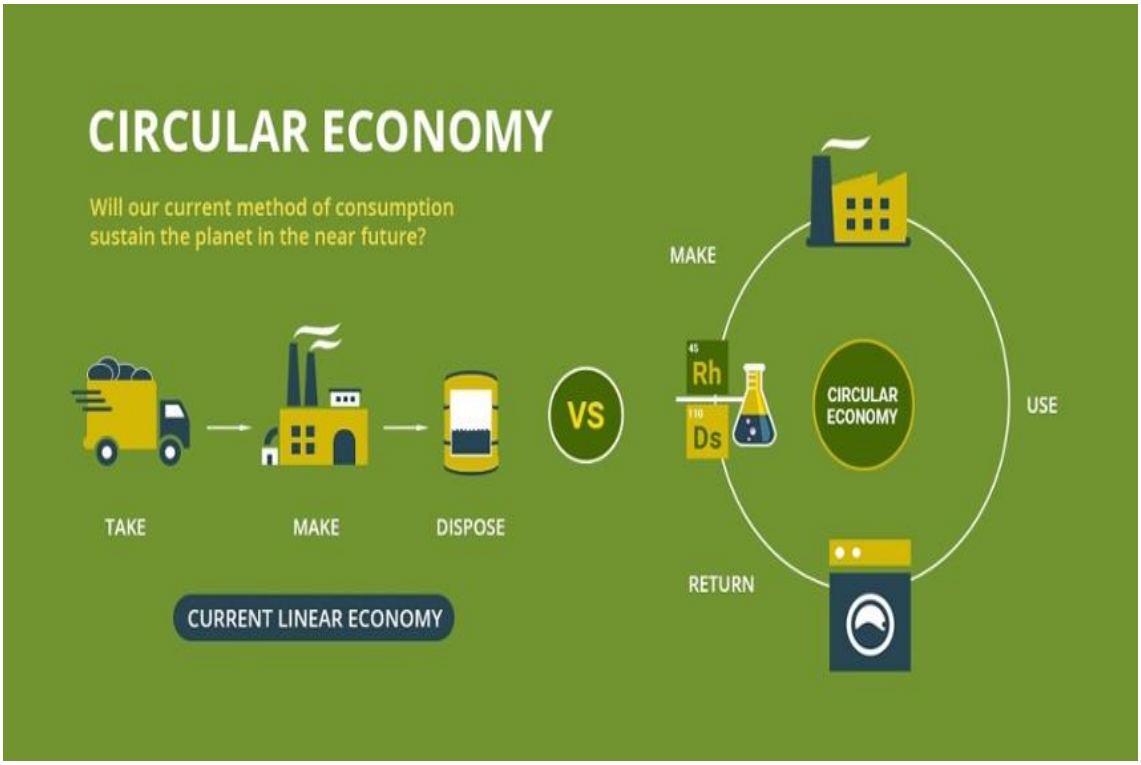

Figure 12: Linear Economy vs Circular Economy (ANDERSEN, 2018)

4 MONITORING AND EVALUATING PROGRESS TOWARDS A CIRCULAR ECONOMY

Due to increase in circular economy not only certain materials or sectors will benefits but it has wide range of benefits, thus systemic change will affect the entire economy and involves all the products and services. But monitoring and evaluating the progress towards circular economy is one of the challenging tasks. Indicators plays important role for capturing trends in preserving the economic value of products, materials and resources as well as in waste generation also.

A set of relevant indicators will be used for analyzing or monitor circular economic activities since just there is no universally recognized indicator for it. With a single measure it is not possible to capture complexity and other dimensions of the transition in a circular economy. So, a set of relevant indicators should be used for monitoring framework. (Ellen MacArthur Foundation, 2016)

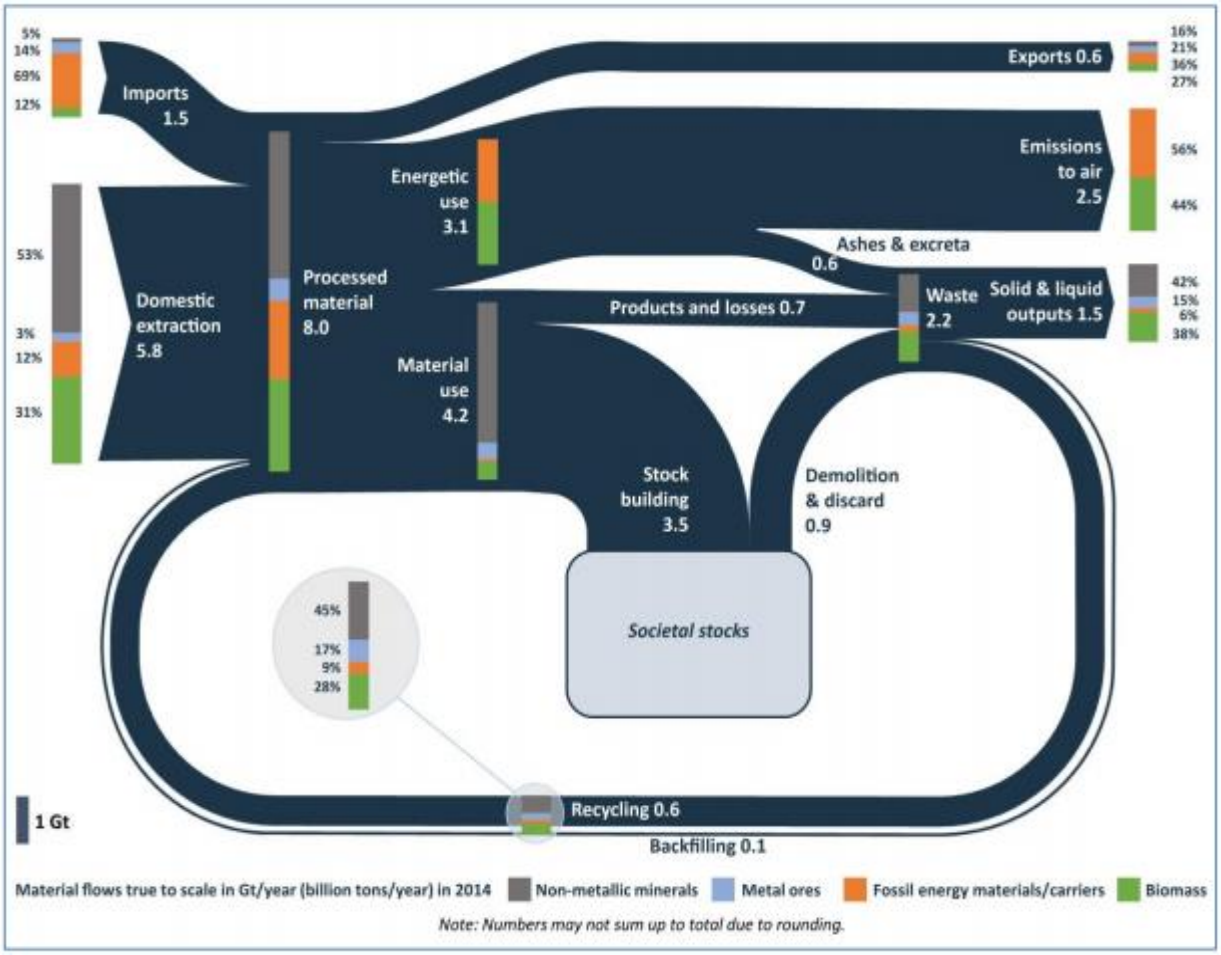

Figure 13: Material flow through EU economy (Commission, 2018)

There are many ways for monitoring but one of the ways is to look how materials enter, flow within eventually leave the economy in any circular economy. Material flow diagram shows big pictures of flow of all raw materials. From Figure 13, in year 2014, it is visible that 8 billion tons of raw materials enter the economy, then they are processed into energy and products. Out of 8 billion tons of materials only 0.6 billion tons of materials are originated from recycling. Total of 2.2 billion tons of waste were generated and only 0.6 billion tons materials re-enter for recycling.

Today, most of the circular economy monitoring are held on national and regional levels and helps to collect data for organizations like Economic Co-operation and Development (OECD) and Eurostat (Resource efficiency scoreboard).

In January 2018, the European commission adopted a new framework for monitoring circular economy as a Circular Economy Action Plan. It helps European commission to keep track of the progress made in economy and provides information towards business and consumers on ongoing developments. The monitoring framework on progress towards circular economy mainly focus on set of 10 key indicators covering different areas of production, consumption, waste management, secondary raw materials, investments, jobs and innovation, and are grouped in four stages.: (1) Production (2)waste management (3) secondary raw materials and (4) competitiveness and innovation. (Commission, 2018)

Figure 14: The circular economy monitoring framework of the European Commission (Commission, 2018)

4.1 Production and consumption

1. *Self-sufficiency of raw materials for materials:* Selecting and making EU self-sufficient in critical key raw materials which are used and produced inside EU.
2. *Green public procurement:* Public procurement holds large share of GDP thus driving circular economy through public procurement which accounts large share of consumption. Giving more emphasis on purchasing power to choose environmentally friendly goods, services and works.
3. *Waste generation:* There is large variation of waste generation including industrial and commercial between each EU member states ranging from 250 kg to 750 kgs per capita per

year. Some of the EU municipal waste generation has dropped by 8% between 2006 and 2016 having an average of 480 kg per capita per year. It is still positive that the total waste (including industrial and commercial) generation data is decreasing.

4. *Food waste:* According to Eurostat's preliminary estimates, EU produces 76 million tons of food waste thus reducing the food waste can contribute on saving the resources. Food is the major player in economic value chain during production and distribution. But it is decreasing by around 7% between 2012 and 2014 making waste per capita of 149 kg.

4.2 Waste management

1. *Overall recycling rates:* The overall recycling rates for municipal waste in EU increasing from 37% to 46% and the commission's recycling target on 2030 is 65%.
2. *Recycling rates for specific waste streams:* Recycling rate of overall waste like plastic packaging, wood packaging, electrical and electronic equipment waste are increasing. The rate of recycling of plastic packaging is below 40% as well as biowaste recycle has reached 79 kg per capita in 2016. There is vast difference in each state of EU considering recycling rate.

Figure 15: overview recycling rates of different waste streams. (Commission, 2018)

4.3 Secondary raw materials

1. *Contribution of recycled materials to raw materials demand:* Secondary raw materials are those raw materials that are produced from recycled products which has reached their end-of-life. In EU, only 10% of demand is fulfilled by recycled materials so, the contribution of recycled materials to overall materials demand is relatively low but the trade of secondary raw materials is increasing inside EU as well as with countries outside EU.
2. *Trade in recyclable raw materials:* EU is the next exporter of several major recyclable raw materials like plastics, paper, iron steel copper, etc. and trading of these materials is increasing day by day.

4.4 Competitiveness and innovation

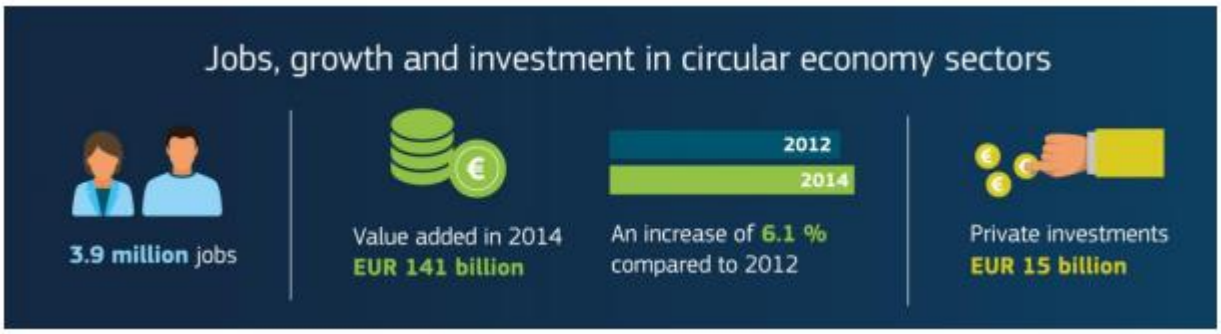

Figure 16: Jobs, growth and investment in circular economy sectors (Commission, 2018)

1. *Private investments, jobs and gross value added:* When economy is transited to circular economy, there will be very good opportunity of increasing investments. In 2014, around €15 billion was invested by private investors inside EU. Even though having a huge economic and financial crisis in EU, the circular economy created nearly €141 billion of value added and it is increasing at rate of 6.1%. Several programs are funded by EU to support the transition to a circular economy the programs like European structural and investment funds, European fund for strategic investments, Horizon 2020 and LIFE are some of them. In January 2017 a Circular Economy Finance support platform was introduced.

2. *Patents:* Data reveals that around 35% increase between 2000 and 2013 for patents on recycling and secondary raw materials. EU represents around 44% of the world total such patents in glass recycling, 18% in plastics. Patents create wealth thus providing patents helps to provide intellectual safety and motivation for invertors for further innovation.

5 EXISTING EU MEASURES

The aim of Europe 2020 strategy is to increase jobs and growth with sustainable and inclusive economy which can provide increase productivity and social cohesion. Through its strategy, the EU will have efficient, greener and more competitive economy. European Structural and Investment Funds (ESI Funds) is one of the key instruments to obtain these objectives.

The five ESI funds working together across all EU countries are:

1. European Regional Development Fund (ERDF)
2. European Social Fund (ESF)
3. Cohesion Fund (CF)
4. European Agriculture Fund for Rural Development (EAFRD)
5. European Maritime and Fisheries Fund (EMFF)

ERDF and CF funds are related to waste management including recycling, innovation, construction and upgrading, increase recycling capacity and promote cooperation with other programs specified by national or regional programs. Total amount of €36 billion was allocated for environment and resource efficiency budget and total of €41 billion for research and innovation in time period from 2014-2020.

European Investment Bank (EIB) Group and European Commission jointly launched an initiative known as The European Fund for Strategic Investments (EFSI) to decrease the current gap in EU by mobilizing projects with private investment which are strategically important for the EU. EFSI will facilitate around €315 billion in the area of sustainability, development and modernization of the energy sector, renewal energy, security of energy supply and resource efficiency. (European Commission, 2018)

6 TURNING VISION INTO REALITY

To gain the success, and achieve the goals seen by EU, some set of measures should be implemented so better regulation principles should be forwarded. Any measures are likely to have significant socioeconomic impact. To overcome this impact, assessment should be established. Horizon 2020 is EU research program, where funds are to be provided for research and development to grow importance of plastics in the circular economy. Now €250 million seed fund is available for this purpose. By 2020, additional €100 million will be provided which will help to develop smarter and more recyclable plastics materials, more efficient recycling process, for removing hazardous substances and contaminants from recycled plastics. To develop the biodegradable plastics, €9 million fund will be provided for project called CIRC-PACK which helps to provide an alternative bio-base with eco-design packaging. €3 million will be funded to CLEANSEA project to collect and monitor litter and advise policymakers on preventing litter. Project RES URBIS will get €3.3 million for production of bioplastic utilizing urban biowaste European Union are doing strategic investments by funding €7.5 million in recycling and circular economy project which will create 280 full-time jobs and 50000 tons of waste is collected and processed per year. Forcing cities to reduce emissions by 12,500 tons of CO_2 and cooperating in circular economy and upgrading 5000 tons of flexible plastics from enterprise, private households etc. (commision, 2015)

6.1 Improving the economics and quality of plastics recycling

Recycling plastics not only help in economy but also benefits environments keeping the use of resources low. To achieve the high value for plastics recycling, focus should be given on improving the way plastics and plastics particles are produced and designed. It cannot be only achieved by initiation by few, it should be implemented and cooperated by all the value chain from industry, manufactures, private waste management companies. All the key players should work together so that design of plastics can be made in such a way that it will make easier for recycling and encourage for innovative way for designing plastics to support the cause. key players should work together to expand and improve the way of collecting plastic waste, modernizing the EU's sorting, increasing recycling capacity, creating viable market for secondary raw materials and making ensure quality inputs for recycling industry.

European commission are facilitating and involving many key players together and having dialogue to help and back the vision for 2030. The commission has already proposed new rules and regulation on waste management and encourage national authorities to buildup separate collection, investment

in recycling capacity and overcome processing mixed waste. The commission will even cooperate with different players in future to increase waste recyclability under set rules and regulation.

Design for recyclability

Today, most of the products made from plastics are not so much recyclable because of its design. Producers are not taking any initiative to make the process easy and simple. Most of the products made are highly customized with range of polymers and additives contents which will make recycling process more complicated. Plastic packaging holds most of the waste created in EU accounting around 60%. If products are designed properly, the recycling cost will decrease thus making recycling process more desirable. In 2015, the commission proposed a plan to recycle at least 55% of all plastics by 2025 and reducing the cost of recycling in half and supporting internal market thus encouraging to improvise the design in products. By 2030, the EU has goals to make all plastics packaging reusable and easily recycled. Reward system will be introduced to encourage better designs.

Other sectors which produces significant amount of plastic waste like construction and automotive, furniture and electronics are also facing same problem as packaging industries, mainly due to its design and concern of chemical content. So, to overcome these difficulties, the commission has proposed ways to identify the possible chemicals easier to trace and recycled streams. Its main aim is to make recycling process easy and minimize the effect of chemicals thus ensuring health and environment protection.

While design can increase the recyclability but there are some factors which can create issue and hold the whole process is stake like additives present in plastics. Additives are quite difficult to remove from plastics. Additives can contaminate soil, air, water and food which can be exposed to humans and can be fatal. Plastics can be classified according to its chemical structure as well as chemical process used in their synthesis. It can also be classified based on its properties like thermoplastic, biodegradability, electrical conductivity, density or resistance to various chemical products which is key factor while designing products. The addition of additives helps plastics to build several specific properties (e.g. hardness, softness, UV resistance, flame retardant) thus making it versatile material for production products. But, however, the additives in plastics can cause problems or can be hazardous while recycling. (European commission, 2018)

Lists of additives found in Plastics

Type	Typical amount range (%w/w)	Additional comments-explanations
Functional additives Plasticizers	10–70	About 80% is used in PVC while the remaining 20% in cellulose plastic.
Flame retardants	3–25 (for brominated)	To prevent ignition or spread of flame in plastic material.
Stabilizers, Antioxidants and UV stabilizers	0.05–3	The amount depends on the chemical structure of the additive and of the plastic polymer. Phenolic antioxidants are used in low amounts and phosphates in high. Lowest amounts in polyolefins (LLDPE, HDPE), higher in HIPS and ABS.
Heat stabilizers	0.5–3	Mainly used in PVC. Based on Pb, Sn, Ba, Cd and Zn compounds. Pb is the most efficient and it is used in lower amounts. The amounts are dependent on the chemical structure of the slip agent and the plastic polymer type.
Lubricants (internal and external) 0.1–3	0.1–3	To prevent damage to plastics or the mold during processing. Applied to the material or directly to the machine to allow processing without damage.
Anti-statics	0.1–1	Help to prevent the build-up of static electric charge. Plastics are generally insulating and so have the capacity to build up static charges on the surface which greatly disturb processing procedures.
Curing agents	0.1–2	
Blowing agents	Depends on the density of the	Form gases in the plastic to produce a foam material. The blowing agents form gases by breaking down on heating at a

	foam and the potential gas production of the agent	pre-determined temperature and form a foam structure within the plastic's polymer matrix.
Biocides	0.001–1	Soft PVC and foamed polyurethanes are the major consumers of biocides.
Colorants Soluble (e.g. AZ colorants)	0.25–5	They migrate easily and are used in highly transparent plastics. They are expensive, with limited light and heat resistance. Mostly used in PS, PMMA and cellulose plastics to give a bright transparent color.

Table 1: lists of additives found in plastics (John N. Hahladakisa, 2018)

Boosting demand for recycled plastics

At present, the demand of recycled plastics is very low due to which obtaining the goal has become quite difficult and it has also created major obstacle to transforming plastics value chain. Now, it remained in low value chain, this is due to many reasons where one of the reasons is giving misinformation by many product brand and manufacturers and other reason is misconception about its reliability. The high-volume supply of materials is still lacking which fears manufacturers that their necessity will not be fulfilled. By observing all the problem related with recycled plastics, the commission is working with European committee for standardization and the industry to develop quality standards for sorted plastic waste and recycled plastics. The chemical present in the plastics before recycling also plays major factors for low demand. So, EU is financing research and innovation projects through HORIZON 2020 to identify the contaminants and decontamination on plastics. For more safety, the commission will finalize the authorization procedures for over a hundred safe recycling processes. By 2025, the commission has targeted to make new products for EU made by recycled plastics where 10 million tons of plastics will be recycled.

Separate and effective collection and sorting

The lack of well management of collecting plastic wastes has played a role for holding back in recycling. A good management of collecting plastics means effective way of collection as well as sorting. Sorting plays vital role because in this process contaminants are avoided while doing recycling. It will help to obtain high safety standards for recycled materials. Thus, every level of authorities as well as waste management operators should raise public awareness and ensure high-quality separate collection. The commission will issue separate new guidance for EU to have standardized and effective practice for separate collection and sorting waste while supporting the European Parliament and their Council on their present efforts. (European commission, 2018)

6.2 Curbing plastic waste and littering

Everyday millions of tons of plastics are dumped in the water resources like ocean, sea, lakes and rivers due to which has caused negative impact in water life. Many aquatic lives are in a brink of extinction due to hazardous effect of plastics waste. According to one study, at least 8 million tons of plastics leak into the ocean every year which is almost equivalent to dumping of one garbage truck in every minute, it is estimated that this is about to increase to two garbage truck per minute by 2030 and four per minute by 2050 if action is not taken.

The life-threatening plastics waste are in form of micro like microplastics, which are small particles of large abundant plastics which are degraded over time. Many aquatic animals often eat microplastics because of their sizes and they die after a long suffering. Plastics contain toxic chemicals which have very direct effect like chances of increasing disease and affecting the reproduction. 80% of the microplastic particles are from sources like bottles and bags as well as the fishing equipment's abandoned or lost in the sea. Lost fishing equipment like nets can entangle and kill whales, dolphins, turtles and other sea animals. (World Animal Protection, 2017)

Figure 17: Whale died eating plastics (Phys.org, 2013)

In Figure 17, sperm whale of 4.5 tons, died ingesting large amounts of plastic and washed ashore in southern Spain. The whale has ingested dozen meters of plastic rope, plastic sheeting which are used for greenhouses. Other marine animals have also faced many life-threatening problems in that area due to plastic sheets which are used for greenhouses on farms in that region. Due to this incident, many biologist s as well as people around that area have shown deep concerns.

From Figure 18, it can observe that the estimated time required for decomposition for different types debris item. Since it takes more than centuries for plastics debris to decompose, it will create catastrophic impacts on marine lives.

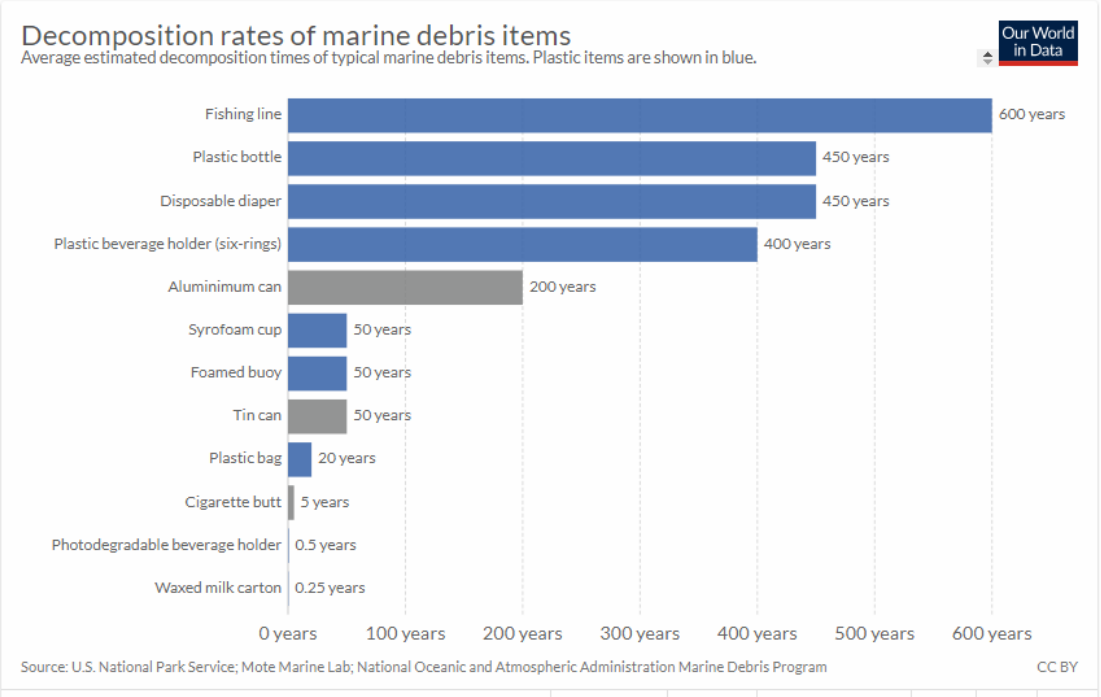

Figure 18: Decomposition rates of marine debris items (Our world in Data, 2018)

The EU has already taken steps with its Member States to adopt measures to cut the consumptions of plastics package and monitor and reduce marine litter. EU is providing funds to combat the rise of marine litter, supporting global and national and regional action. The commission is introducing drinking water directive so that each citizen can have access to tap water so that it can reduce the use of bottled water. The addition measures like reuse of packaging is encouraged. The commission is trying to discourage the single use of plastics while promoting the recycling process. Many projects funded by EU like European Solidarity Corps with a budget of €341.5 million are running to spread awareness and for other works like cleaning up beaches, preventive measures that can provide huge opportunities for everyone.

6.3 Driving innovation and investment toward circular solutions

To drive circular economy, the unlimited sources of raw resources in not required, by maintaining limited consumption and well-maintained recycling process, a healthy circular economy is sustainable. To reach the objectives need innovation and investment. Investing on technologies can be risky and costly because of different factors like banks, venture, capitalists but it can be detrimental factor in terms of incentives to have an innovation that can provide a smart and sustainable alternative for all. It can help to close the knowledge gap that lies between micro-plastics release in environment

and impact on human health. But to achieve all it requires funding, a well-made policy and right approach. There are many obstacles in different phased which can hamper all the goals to be achieved, like in raw material production phase, underdeveloped chemical technology as well as fossil plastic raw materials cheaper than secondary plastics, uncertainty about supply of secondary plastics, doubt on quality and safety, design for recyclability. In manufacturing phase, presence of hazardous substances, switching from linear model to circular model, not having clear regulatory framework and lack of infrastructure for plastic waste recycling can discourage investments. In Use phase, price of product, functionality of products, lack of insufficient of infrastructure for disposal and public waste management also discourage investments. In End of life phase, recycle cost, market price, improper design, too complex environment regulation, lack of collection schemes for every types of plastics too discourage investments. Even though having so much challenges, still needs important investments because of current market conditions, protecting environment and human health thus EU is running policies from where required funds are collected and then invested.

EPR and DRS are two schemes which are currently implemented. EPR (Extended Producer Responsibility) is known as an environmental policy approach. It deals with producers at post-consumer stage. Producers must provide financing and management for the waste management of their end-of life products. By doing this, producers are encouraged for production well designed products which can be recycled easily. In addition, tax burden from taxpayers can be reduced. In DRS (Deposit return schemes) in some products addition fee added to consumer as deposit and it will be return when consumer bring them back. This scheme is applied mostly in packaging materials like drinking bottle etc. This scheme had become quite success in many EU member states. In Finland, return rate is 92.6%. It encourages consumers to save, collect and return to the collecting point. (European Commission, 2018)

6.4 Harnessing global action

In 2015, UN member countries adopted 2030 agenda for Sustainable Development which has 17 sustainable development goals, which are also related with plastics strategy. To achieve the goals, it required local, regional and global level commitment, where European Union can play important role to establish co-operation, waste management and using its experience of circular economy. United Nations Environment Program's (UNEP's) main task is to combat marine plastics litter and micro-plastics working alone with regional, sub-regional and international governance. UNEP's Global program of Action for Protection Marine Environment from land-based activities (GPA) and Global

Partnership of the Marine Litter (GPML) are working to find the impacts of plastics waste entering the sea from land. The International Maritime Organization (IMO) is working to address issue the plastics waste and other types of waste discarded from ships. The International Convention for the Prevention of Pollution from Ships (MARPOL) prevents and prohibits the discharge of garbage like foods, domestic and operational waste, fishing gears etc. from ships to sea. (European Commission, 2018)

EU had directly participated in decision-making processes under Multilateral environment agreements (MEAs) and provided guidance to all countries e.g. on chemicals and waste management. European Union had organized many high-level events and did commitment for safe, clean and sustainable to manage ocean. More than €3 billion of fund was also committed in meeting. EU has has also dedicated €238 million to support to improve sound waste management in outside of EU countries. EU will also help to transit outside of countries to circular economy and committed 202 million euros. EU is running switch to Green program in Asia and Africa which raises awareness to support recycled plastics-based business development.

EU is doing coordination with G7 and G20 nation to address different issues related to resource efficiencies, marine litter, waste management etc. These nations and EU are sharing knowledge and innovation to tackle the problem and support the SMEs. The vision of coordination is to reduce, reuse and recycle which will be implemented through 5 years Bologna roadmap. EU is doing bilateral and region cooperation within the regional nations as well as nation like China and India which to plays major role in solving this problem. In regional region, action like ECRAN which is running in Balkan countries, is helping to move gradually from landfill management to integrated waste management. A project, Eco Awareness Campaign is also running in Montenegro to tackle the use of plastics bags and related pollution issues. (European Commission, 2018)

7 RECYCLING PROCESS OF PLASTICS

Recycling is the care process which runs the circular economy. Plastics recycling is the process of recovering waste and scrap plastics from different sources and the recovered waste is reprocessed to make functional and useful products. The aim of recycling the plastics is to minimize the plastics pollution as well as to reduce the use of untapped natural resources. Doing this helps to conserve natural resources, provides cheap secondary raw materials as well as prevent the waste going to

landfill or into the oceans. Recycling plays Vital role in circular economy and it helps to increase the value chain of plastics and its products.

Since plastics play very important role in people's life due to its unique characteristics which can be molded easily to provide any shape and size thus the use of plastics will be increased in the future so recycle and recovery of plastics is very necessary. Every year millions of tons of plastics are used and wasted, it is estimated that the demand of plastics has reached 49.9 million tons in 2016 and most of the demands came from plastic industries like packaging, building, construction and automotive. Among these packaging industries around 62% of total waste is in Europe.

The collection of plastics for recycled has increased every year reaching 31.1% in 2016 from 26.3% in 2012. In 2016, around 27.1 million tons of plastics waste were collected of which around 8.43 million tons were recycled and around 11.27 million tons were incinerated. Energy recovery rate also increased from 35.8% in 2012 to 41.6% in 2016 while plastics waste going to landfills has decreased from 38.1% in 2012 to 27.3% in 2016. (Plastics Recycler Europe, 2019)

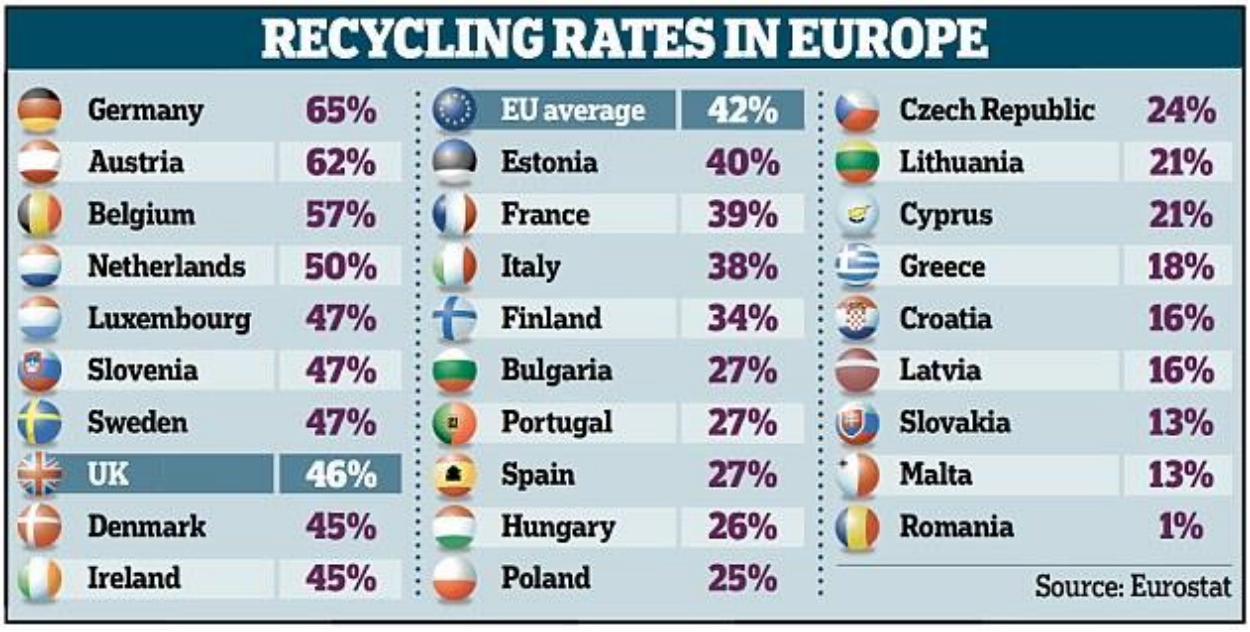

Figure 19: Wastes recycling rate in each EU member states (Groves, 2014)

Recycling some of the plastics will be very hard due to presence of additives or due to economic viability as well many factors affect it like many plastics are hard to isolate from other waste, Harmful chemicals can be neutralize by doing incineration and plastics must be sorted according to resin identification codes which indicates the types of materials they are made from

Symbol	Polymer type	Examples	Recyclable?
1 PETE	**PET** **Polyethylene Terepthalate**	Fizzy drinks Mineral water Squashes Cooking oils	✓
2 HDPE	**HDPE** **High Density Polyethylene**	Milk bottles Juice bottles Washing up liquid Bath and Shower bottles	✓
3 V	**Polyvinyl Chloride**	Usually in bottle form however not that common these days	✓
4 LDPE	**LDPE** **Low Density Polyethylene**	Many types of packaging are made from these materials for example, plastic formed around meats and vegetables	Due to the mixture of compounds these plastic types are hard to recycle
5 PP	**PP** **Polypropylene**		
6 PS	**PS** **Polystyrene**		
7 OTHER	**Other** **All other resins and multi-materials**		

Figure 20: Various plastics that can be recycled or those that cannot (Anon., 2019)

At present only few types of plastics like PET, HDPE and PVC are recyclable under curbside recycling programs. Whereas other plastics like PS, PP and LDPE are not recycled for different factors like its characters which is difficult to recycle as well as sometimes economically it is just not affordable.

Plastics recycling

Plastics recycling is done with few distinct steps and generally recycling process involves is similar most of recycling facilities few process cycles may be added or reduced as required. While recycling

the plastics waste, chemical hazards situation should be taken to account because as it consists of different kinds of chemical as well as resins.

Step 1: Collections

The initial stage of plastics recycling is collections of plastics wastes from different sources like households, businesses, restaurants and the public. The separation of plastics waste is very important so that it can be easily recycled at recycling facilities. If it is not separated with common waste, it cannot be recycled. For easy collections, local collection points should be made easily accessible to public and government should make ideal rules and regulation for collection systems thus it will encourage public for recycling.

Step 2: Sorting

After collection, transportation is done to a recycling facility where sorting is done as requirement. It is sorted according to what types of product to be produced. In recycling facilities, plastics are sorted based on the composition of plastics It includes which material composition, color of plastics and how it is made. It is important because different plastics must be processes in different processing methods. Since, recycling facilities are only capable of recycling only one type of plastics, if wrong types of plastics are processed in incorrect facilities, it can affect the efficiency of machine reducing it and whole process require to be sent back for resorting again.

Step 3: Washing

Washing is just a simple step while doing recycling. Its main purpose is to remove impurities from the waste as well as also to remove the things that are not made from plastics. If it is not removed it can affect the whole process and can cause degradation in final products. Most Plastics waste contains many levels, adhesive or even food residue that must be removed.

Step 4: Resizing

The main objective of this process is to cut plastic waste in desirable size which makes easy for other process. Resizing can be done by shredding or granulating. It also gives opportunity to remove undesired impurities.

Step 5: Identification and separation of plastics

In this process, identification of quality and class of small sized plastics are made and after that it is separated. For identification and classification, different test like density tests, air classification test, melting point test and color test are done. The first test to be made is density test where small sized plastics are categorized by floating method, in a large tank of water, all small particles are put and observed and separated according to its density. Plastics having less density than water will float while having density it will sink.

The next process is air classification, which determines how thick and thin the small size particles are by dropping the particles into a small wind tunnel. In this process, bigger pieces of plastics will remain low while small pieces will lie above. Different types of plastics have varying melting points and thus by this method plastics are categorized, and color of plastics also plays vital role while doing classification.

Step 6: Compounding

Compounding is a final process where small pieces of plastics are smashed and melted together to form plastic pellets. Plastic pellets are small granules shaped in cylindrical or disk form with a diameter of a few millimeters. It is main the sources for any plastic productions which are used in industrial sectors. (Greentumble, 2018)

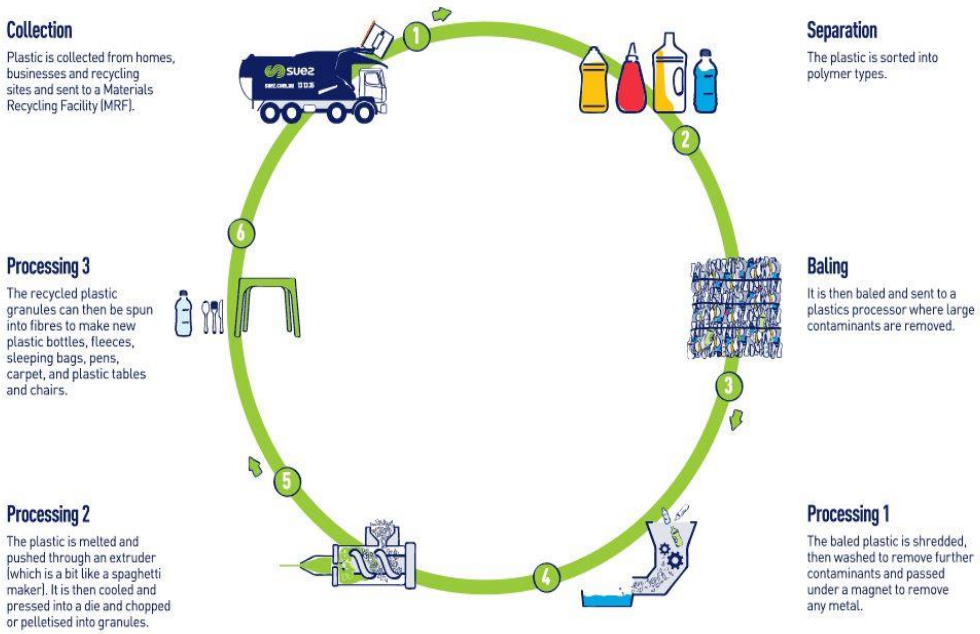

Figure 21: Plastic recycling process (Suez, 2019)

8 DISCUSSION

The transition of linear model economy to circular model economy is not an easy task. There are many limitations like lack of infrastructures, lack of awareness, economies viabilities, etc. Recycling being core part of circular model economy, enough percentage of recycling had not achieved. This problem is occurred due to costs, design of products, presence of additives and resins etc. The limited amount of secondary raw materials produced by recycling didn't have so much demand due to lack of trust in its supply. There is also misconception about the quality of secondary raw materials being low. Using circular economy action plan framework, the progress of transition of linear model towards circular model can be obtained. While transiting to circular economy, it is also important to create jobs so that sustainable and competitive economy environment can be obtained. To have sustainable circular economy, good infrastructures like collecting, sorting and recycling plant should be needed. EU has set different timetables for different tasks to be completed like by 2030 in EU making all plastic packaging reusable or recycle, recycling up to 50% of plastic wastes. modernizing modern recycling capacity, etc. Funds provided by EU to different projects are playing every important role to achieve the goals.

9 CONCLUSION

To fulfill the visionary plan where challenges are very big, it needs a well set of plan and strategy. Challenges that are linked with production, consumption and end-of life of plastics can be changed to a great opportunity and increasing the competitiveness of industries in EU. Transiting linear economy to circular economy and creating jobs, growth, innovation and increasing value chain is a strategic vision and making environment friendly where citizens can have cleaner and healthier environment. To achieve this plan, EU and every government level in Member states, regions and cities should show commitment, as well as good fund for different projects should be allocated. To follow the transition progress good monitoring and evaluating system should be implemented, efficient system of recycling and good supply chain for secondary raw material should be established, thus by doing this, the EU vision can be achieved.

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