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# Ethical issues related to recycling of German plastics in Asia.

Metropolia University of Applied Sciences

Bachelor of Business Administration

European Business Administration

Bachelor's Thesis

04.05.2021

Author Title	Kai Hofer Ethical issues related to recycling of German plastics in Asia.
Number of Pages Date	35 pages 4 May 2021
Degree	Bachelor of Business Administration
Degree Programme	European Business Administration
Instructor/Tutor	Senior Lecturer Kaija Haapasalo
<p>Plastic recycling is a topic very present in the global media. However, German consumers are not very aware what happens to their plastic trash after being placed in the recycling bin. Germany has developed several recycling systems which proof to be highly efficient for example with PET bottles, but other plastic materials are still not treated properly or not being processed at all. On a national, as well as European level, there have been plenty of efforts to tackle the plastic crisis, we are facing right now, but these efforts are not helping countries, which are receiving the excess trash from Germany.</p> <p>This thesis is based on qualitative research and analysis of secondary data such as professional literature, online publications, and statistics. With the theoretical framework based on international trade theory, this thesis aims to analyse how nations are interacting in the international trade of plastic waste.</p> <p>The main target of this thesis is to explain the causes that have led to this ethical problem and to provide solutions how to lessen and change the negative impact. Three research questions were formulated to support the study. Firstly, what impact did the Chinese import restrictions for plastic waste in 2018 have on the global plastic recycling industry? Secondly, how trading of plastic scrap is failing in matters of social, environmental, and ethical issues internationally and especially in Germany and finally how bioplastics and a circular economy present a viable solution to the global plastic crisis.</p> <p>Mainly Southeast Asian countries, except China, were the destination for German and European plastic scrap in 2021. These developing countries are struggling to integrate the foreign trash into their recycling system since environmental issues have not been as urgent as other problems, such as poverty, that these countries are facing. However, the governments in these nations are gradually realizing that importing plastic scrap is causing environmental, health and socio-economic problems and have therefore either announced immediate restrictions to stop the import of trash or set a timeline to eliminate this mechanism in the next years.</p> <p>Main findings and conclusions of this thesis are that unfortunately Southeast Asian countries will remain the main importer of excess scrap of developed countries in the near future. It cannot be clearly said which country will take over the place of China as the world's biggest recycler. Inadequate handling of plastic scrap from Germany in Southeast Asian countries is a main contributor of the huge amount of maritime plastic pollution these countries are emitting. However, there are solutions like encouraging economies to switch from the current linear consumption model to a more sustainable circular economy system moreover, bioplastics could provide a sustainable alternative to the current petroleum-based plastics which cause our recent environmental crisis.</p>	
Keywords	Plastic, Recycling, Environment, Plastic usage, Bioplastics, Germany

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**Glossary**

CE	Circular Economy
CRS-policy	Chinese recycling subsidy policy
DC's	Developed countries
LDC's	Lesser developed countries
NABU	Nature and Biodiversity Conservation Union
OECD	Economic Co-operation and Development
PLA	Polylactic Acid
TEU	Twenty-foot equivalent unit, an inexact unit of cargo capacity.
WWF	World Wildlife Fund

## 1. Introduction

The trading of plastic waste between Europe and Asia goes back more than 50 years. After the Second World War plastic production increased in developing countries due to the linear economic system. This system was established to create wealth and prosperity in post war times, and it has vastly increased the amount of discarded plastic trash. Linear Economy is a system of extracting raw materials, production, usage and discarding the waste (Government of the Netherlands, 2017). This structure is simply unsustainable. Facilities in developed countries that are using this system, including the European Union, have not been able to recycle all their trash in their own countries. For over 10 years, excess plastic scrap has been exported to Southeast Asia, China being the major importer of this material. Until recently, most of this waste was shipped through Hong Kong to mainland China and collected further from there. The plastic was recycled, and plastic pallets produced during this process were used to create recycled consumer goods for the global market. (Jan Dell, 2019)

However, environmental issues, global awareness and politicians addressing this topic have made a major impact on consumers' attitudes towards plastic. Attempts to substitute and replace plastic as much as possible have been recognized among concerned citizens and included into the political agendas. On the other hand, many developing countries have not changed their attitude towards plastic and continue to consume and discard most of the world's plastic scrap. Asia and Africa are experiencing a significant increase in population, which correlates with higher plastic consumption and the corresponding plastic trash problem seen in the world. While travelling and working in Asian countries my personal awareness increased, I saw how urgent the situation is and how quickly this topic must be addressed to achieve a sustainable future for the environment and humanity.

At the supermarket, it's easy to see the problem we are facing. Almost everything from food and beverages to cleaning supplies contains plastic packaging. The department with the highest number of plastic packages is the beverage department. More than three-fourths of all beverages are packed in PET bottles. Even though this material is branded as 100% recyclable and consumers are returning these bottles in many European countries, it can be said that some bottles still end up in nature. Germany exports the most plastic scrap within the European Union and is thereby a main contributor to the plastic problem in Asia and the world. Therefore, Germany is used as

a case study in this thesis. It is the biggest economy in Europe and exports the most plastic scrap abroad. It should be analysed, how exporting of further plastic trash from Germany can be avoided.

Since recycling is another major point to create less plastic, in Germany recycling rates for PET bottles were at 93.5% in 2018 (Schmidt, 2018). This is the highest percentage in Europe and thereby creating another reason, why Germany was chosen to be in the scope of this thesis.

It is becoming increasingly difficult to find items not packed in plastic wrapping. In general, if an item is packed in paper, metal, or glass, it is often more expensive than the same item packed in plastic wrapping. Since all this plastic trash has to be discarded after usage, some European countries, like Finland or Germany have provided bins to help consumers recycle their trash. Consumers in the European Union are aware of their plastic consumption and they are being told that recycling is saving the environment when recycled materials are put correctly into the bins. However, many people do not realize that this is just the very beginning of the trash lifecycle. In fact, much of this garbage is either being burnt, thrown into nature, or dumped into landfills because it is not profitable to recycle certain plastic products (Better Meets Reality, 2019).

Moreover, recycled plastic, as raw material, is not yet a standard used widely by international plastic producers and only some dedicated plastic manufacturers like Alpla are using it (Alpla, 2021). The reason for this is that recycled materials are often more expensive than new petroleum-based plastics (Ambrose, 2019).

Nevertheless, consumers are becoming more aware of the negative impacts of plastic consumption and they are looking for alternatives.

Growing consumer awareness of the environmental impact of plastics trash export and need to find alternatives for packaging and solutions to recycling problems were the incentives behind this research. The recycling industry within Europe and around the world will increase tremendously over the next few decades. Developing countries are predicted to produce more plastic waste every year due to the fact that these economies are predicted to expand rapidly. The recycling industry faces many current and future challenges. It is paramount that viable solutions are quickly found and implemented. Thereby this thesis is analysing the recent past of plastic recycling until now from an ethical and economic point of view. Moreover, this paper is producing possible solutions

to tackle the plastic problem around the world by replacing harmful petroleum-based plastics with bioplastics, which are generally biodegradable and thereby better for the environment. Another main solution presented in this paper is encouraging a more sustainable way of living like switching to circular economy in Germany and in the rest of Europe. This would include less single use plastics, more repairing of products instead of buying new ones and incentives to encourage this behaviour.

### 1.1. Research objectives and scope

There are many different aspects of plastic recycling in Europe and plenty of scientific papers about the negative impacts of plastic consumption all over the world. Within the European Union, Germany is the largest plastic consuming country and thereby also the largest exporter of excess plastic scrap to foreign countries. German consumers are aware of the level of plastic consumption and find creative ways to solve the problem. Recycling is one solution. Another solution is a plastic free lifestyle which some consumers are incorporating.

This paper provides a summary of the recent history of plastic exports from Germany to Southeast Asia and explains how this mechanism changed when China banned nearly all plastic imports in 2018. Moreover, since the root of plastic consumption can be found in the consumption of individuals, German consumers must be guided to change their behaviour towards a more sustainable way of living. Therefore, also solutions to help them achieve this goal are being suggested in this paper.

The main target of this thesis is to provide solutions, which change German and European consumer behaviour from a current linear economy towards a circular economy system in order to reduce pollution and creation of plastic waste. Additionally, the use of bioplastics as a more sustainable alternative is discussed in this paper since the assumption of the thesis writer is that they can provide a solution to the current problems.

The main research questions this thesis is aiming to find an answer to are listed below.

1. How have the Chinese import restrictions for plastic waste in 2018 impacted the global plastic recycling industry?
2. How is the trading of plastic scrap failing in matters of social, environmental and ethical issues internationally and especially in Germany?
3. How could bioplastics and a circular economy present a viable solution to the global plastic crisis?

## 1.2. Methodology

This thesis is based on a qualitative research and analysis of secondary data, which is derived from professional articles and books regarding the topic. Online articles in journals and trustworthy websites have been used as reliable literature sources for this thesis. Statistics of the European Union and international environmental organizations like the WWF, NABU and Greenpeace provided information of the current situation regarding plastic waste, export problems and its impact. The data collection was limited to secondary sources due to the current global situation and ever changing political, environmental but moreover, unforeseeable circumstances regarding the recycling industry globally. Certain data was difficult to collect due to a lack of transparency of information available from China, Turkey, and other Southeast Asian countries. Official data from 2019 onwards is not consistently available neither from the abovementioned countries nor from Germany and the European Union.

Information referred to in this thesis regarding the German market is highly reliable. Environmental parties and organizations in Germany are regularly re-evaluating the current situation and providing therefore reliable updated information. However, data related to the topic of this thesis from Asian countries such as China, Vietnam, and other Southeast Asian countries, is not as reliable because there is less data available, and it might be “whitewashed” to satisfy governmental agencies. (Raleigh, 2020) Reports such as the world bank report of 2018 and 2019 which are quoted several times are sources which this thesis is based on and henceforth reliable sources. Environmental organisations like the WWF, NABU and other organisations have been critically analysed



and only referenced if sources are professional. However, it is impossible to say that these resources are absolutely reliable. Information from a webpage without the name of an author has only been utilized when proven to be correct and consistent with other sources.

Since the trade of plastic waste between Germany and Southeast Asian countries needs to be analysed, a theoretical approach of international trade theories was applied to explain and describe the relationship between two or more nations.

The hypothesis of this thesis is that "Waste disposal and recycling of plastics in Germany and the export of excess plastic waste from Germany to Asian countries can be more ethical in the future and yet successful in trade terms to both parties."

## **2. International Trade theories**

International trade theories are a sub-field of traditional economic studies, which are analysing patterns in international trade and its origins (Anderton, 1995). International trade theories have made a significant transformation from the free trade theories of Adam Smith in 1776 to the most modern concepts like the National Competitive Advantage of Porters from 1990. These theories always include parties, in this case nations trading together, and thereby the idea of creating wealth for both nations. In most cases an imbalance of trade can be found in modern economies (eFinanceManagement, 2021). Since the topic of this thesis is the evaluation of German plastic trash exports to Asian countries, which includes mainly China until 2018, following theories are being evaluated and explained.

### **2.1. Strategic trade theory**

The strategic trade theory is an approach explaining the application of trade policies by various countries. This theory is divided into three general stages. First a government is subsidising research and development costs of a domestic industry or firm. Other possible instruments include trade policies, trade tariffs, general subsidies, and export subsidies. Secondly, the supported industry or firm increases its research and development which thirdly, leads to foreign firms reducing their efforts in the industry

which henceforth creates a strong market position in the economy for the supported firm. This allows the selected firm or industry to capture a larger market share and thereby, industry profits. (Writer, 2020)

Critics of this theory claim that the government interference distorts the market and allows less efficient firms to enter the market (Writer, 2020). However, following this claim, economists have replied with the “infant industry” argument, which needs governmental support to start operating since there are high barriers of entrance. Industries like aerospace, advanced materials, computers, and semiconductors are just some industries, which are sectors applicable to the above-mentioned high barriers of entry. “Strategic” refers to the oligopoly structure of an industry and not its military significance. (ExpertsMind, 2020)

Strategic trade theory has mainly been associated with Brander and Krugman. These economists have tried to capture real life examples in a market with relatively small number of firms, which ultimately leads to an absence of perfect competition. This model allows the consideration of strategic interdependence on a given market and industry. Each firm on the market is sufficiently large to affect other firms’ decisions in matters of pricing, research, investments and more. It must be considered how competitors are likely to react to its decisions. Taking other firms’ counter decisions into consideration is described as conjectural variation (ExpertsMind, 2020) and is taken into consideration in this theory.

Chinese recycling subsidy policy (CRS-policy) is a great example of how government policies are influencing a whole industry in China. This policy is encouraging a closed-loop system while providing subsidies for more recycling in the community and support for facilities specialized in this industry. This policy also influenced manufacturers’ innovation and consumer awareness. According to a study from Chang et al. (2016), this policy had an important role for recycling rates and the reuse industry in China. It offers insightful recommendations, which could be applicable for other nations’ efforts to subsidise the recycling industry. With growing support in both sectors, the CRS-policy was a great success according to the evaluation in this study.

## 2.2. Absolute cost advantage theory

The absolute cost advantage theory of international trade is evaluating the ability of one nation to produce goods cheaper than another nation. Adam Smith was supporting this theory in 1776 and according to this approach, even the international waste trade can be partly explained nowadays. In figure 1, we have two countries A and B, which both produce goods X and Y. Country A would produce 3 units of X and 2 units of Y in one day and on the other hand country B would produce 4 units of X and 1 unit of Y with the same labour costs. As can be seen, country A has a clear advantage in the production of Y since it can produce it with a lower cost than B and country B has an absolute advantage in production of X.

Country A in 1 day's labour produces	3 units of X and 2 units of Y
Country B in 1 day's labour produces	4 units of X and 1 unit of Y

Figure 1. Different market output by country (Shruti, 2019)

With a lag of trade country A would produce 3 units of X and 2 units of Y whereas country B would produce 4 units of X and only 1 unit of Y. Country A will now benefit if it can produce and export good Y to buy more than 2 units of Y. Country B will gain more by producing and exporting X from A by buying more than 4 units of X. Clearly both countries would benefit from this trade as can be seen in figure 2.

	Good X (units)	Good Y (units)
Country A	-3	+2
Country B	+4	-1
<b>Net increase in output</b>	<b>+1</b>	<b>+1</b>

Figure 2. Positive outcome of international trade (Shruti, 2019)

The global output and consumption of both goods would increase by at least 1 unit in each country. This is a simplified version of international trade and since nations are trading with more than one country and cost advantages are not as easy to distinguish this simplified version is being utilised. Regarding this theory, objects of trade can be goods, labour, or cost of capital. (Shruti, 2019)

Since a division of labour is more effective and creates a positive outcome for both nations, both entities would be benefiting from it (Myint, 1977). Every country tends to specialise in the production of goods which it can provide cheaper than other parties. When exchanging these commodities, both nations receive a higher outcome by buying the desired product cheaper from the other nation and provide other products which are easier to produce for themselves to other parties.

Since the objective of this research is to evaluate the trade of plastic trash between Germany and other developing countries, the absolute cost advantage theory is partly applicable. Germany is not able to provide labour, which is competitive in matters of salary to China when recycling plastic waste and China receiving the waste and recycling it, is benefitting by being able to produce and sell other products made out of this waste (averagesalarysurvey, 2021). Thereby it can be argued, that both nations are benefiting from this exchange in terms of pure economic targets. However, the imbalanced environmental and ethical impacts are not considered.

The history and development of plastic trash trade between Germany and China is explained in more detail in Chapter 4.3. In relation to the environmental and ethical impacts and imbalance of this trade, it should be mentioned that China has adopted several trade policies to prevent the country from importing more plastic scrap from foreign countries since the nation is struggling with their own pollution. According to statistics from 2019 China was ranked the highest overall plastic waste disposal nation globally with an average of 59.08 million tonnes of plastic per year (Kwong, 2019).

These international trade theories provide an explanation why countries are trading even though it is not always good to the nature, environment and problems are shifted from one country to another.

### 3. Manufacturing and usage of plastics in Europe

#### 3.1. Definition of plastic and historical usage

Plastic as defined by the Cambridge Dictionary describes a material, which can be shaped into various forms and shapes when soft (Cambridge Dictionary, 2021). Plastic as a material is lighter, more durable and more cost efficient than material which were used before such as metal, glass, or wood. Because of its diversity and ability to be used in every industry the usage of plastic has increased in the last decades.

Scotch Tape was one of the first goods produced using plastic, first being sold in 1930 in the United States. During the Second World War, nylon stockings and parachutes were needed and thereby produced out of plastic since it is such a flexible material. By the end of 1940, producers were transforming plastic into toothbrushes, records, and Tupperware, and by the 1950's and 1960's into sacks, clothing, and toys. Starting with an annual production of just 2 million metric tonnes in 1950 the demand grew to more than 35 million metric tonnes in the early 1970's. (Freinkel, 2011)

Over the next several decades, the demand for plastic greatly increased and became a component seen in automobiles, electronic hardware, tires and many consumer products and packaging. In the year 2000, consumption exceeded 200 metric tonnes of plastic. By 2010, production increased to 300 million metric tonnes and by 2018, 400 million metric tonnes. Experts predict that plastic productions will increase to 500 metric tonnes by 2025. (Geyr et al. 2017)

There is a vast range of plastic products in circulation, but the most distinguishable is the PET bottle (Polyethylene terephthalate) which is mainly used for beverage containers and is the easiest to recycle. Shampoo and soap containers are mainly made of HDPE (high density polyethylene) which contains a high purity of ethylene and therefore increases the recycling rate meaning the percentage of material, which can be successfully reconverted into new objects. On the contrary, LDPE (low density polyethylene) used in vitamin pill containers or some plastic bags, contains only a relatively low density of ethylene, which makes reusing this plastic more difficult. (AAA Polymer, 2020)

Plastics which are almost impossible to recycle include PVC (Plasticized Polyvinyl chloride or polyvinyl chloride) used in cordial, juice or squeeze bottles, PP (Polypropylene) in lunch boxes, takeout food containers, ice cream containers, and PS (Polystyrene), which is mainly found in foam drinking cups, plastic cutlery, containers, and yoghurts (AAA Polymer, 2020).

### 3.2. Largest manufacturers and their impact

The largest plastic producers in Europe are Germany, Austria, and the Netherlands. In these countries, there are big transnational companies like BASF, a chemical company in Germany, Alpla based in Austria and LyondellBasell located in the Netherlands. These companies are producing mainly blow-molded bottles, injection-molded parts, and special articles for customers, which are non- blow-molded products. The American Dow Chemical firm, LyondellBasell and ExxonMobil are companies with the highest market shares among the international plastic producers. Besides these big players there are also smaller producers like SABIC from Saudi Arabia and LG Chemical in South Korea which are trying to differentiate from their bigger competitors with a different product portfolio. (BizVibe, 2020)

In figure 3 it can be seen how a blow-molded procedure is transforming a plastic blank into common PET plastic bottles.

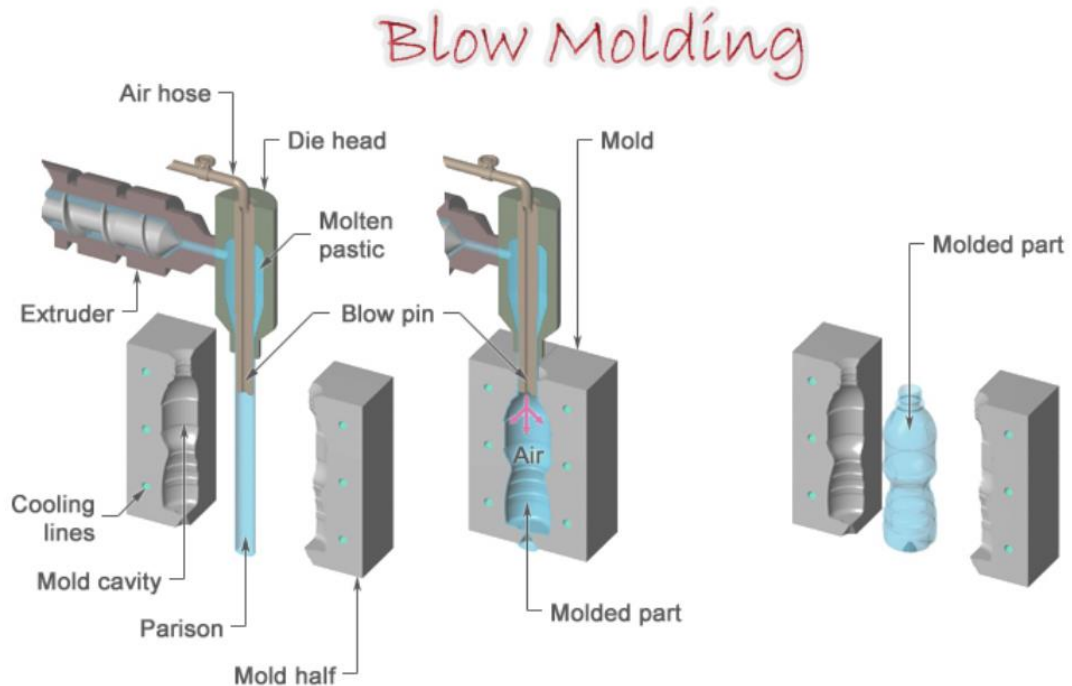


Figure 3. Simplified illustration of PET bottle production in an injection stretch blow moulding procedure (Thell, 2016).

During the last two decades the production of plastic has shifted to Asia. China is now the largest producer of plastic. It produced 28% of the world's production of polyurethanes and thermoplastics in 2015. When looking at the rest of Asia, another major producer, with roughly 4-5% market share is Japan. The other countries in Asia account for nearly 17% of global production. Meanwhile, the US, Canada and Mexico created 18-19% of the global supply in 2015, with Europe producing the same amount. Latin America, the Middle East and Africa produced around 12 % of the global plastic production of polyurethanes and thermoplastics in 2015 (PlasticsEurope, 2016, p. 13). Consumers are demanding more plastics and producers are working to fulfil this demand. Because of the predicted increase of plastic products there will be tremendous amount of damage to the natural ecosystems as well as to food chains and finally to humans as well since we depend on these food chain. (World bank report 2018, p.16)

### 3.3. Major plastic consuming industries in Europe

The main industry consuming plastic in Europe is the packaging industry, with a share of 39%. Building and construction industries are capturing 19.8% market share. The third

largest group of plastic consuming industries is the combination of producers of appliances, mechanical engineering, furniture, and medical equipment. Together they cover 16.7% of the market. Automotive companies make up 9.9%, electrical & electronic appliances 6.2%, household, leisure, and sports 4.1% and agriculture 3.4% of the European plastic consumption market. In absolute numbers, the demand for plastic in Europe was 51.2 metric tonnes in 2018. (PlasticsEurope, 2019, p. 20)

The industries mentioned above are mainly using PP, LDPE, HDPE, PVC, and other plastics, but only PET / PS in low amounts. Since only half of these plastics are recyclable, this consumption of plastic is creating plenty of rubbish, which is either incinerated in the plastic consuming country, partly recycled within these countries, or shipped to Southeast Asia.

#### **4. Generation and disposal of plastic waste**

##### **4.1. Current level of waste generation and collection**

Of the trash collected in the recycling bin, much of it is not automatically recycled and made into new material as seen in figure 4. Only 32.5 % of the collected trash is recycled whereas 42.6% is used for energy recovery, which means it is burned for energy and heat. The rest, or 24.9% ends at landfills all over Europe. Of the 32.5 % that is recycled, a majority (81%) is recycled and treated within the EU and 19% is shipped abroad to be sorted and transformed into recycled products (PlasticsEurope, 2019).



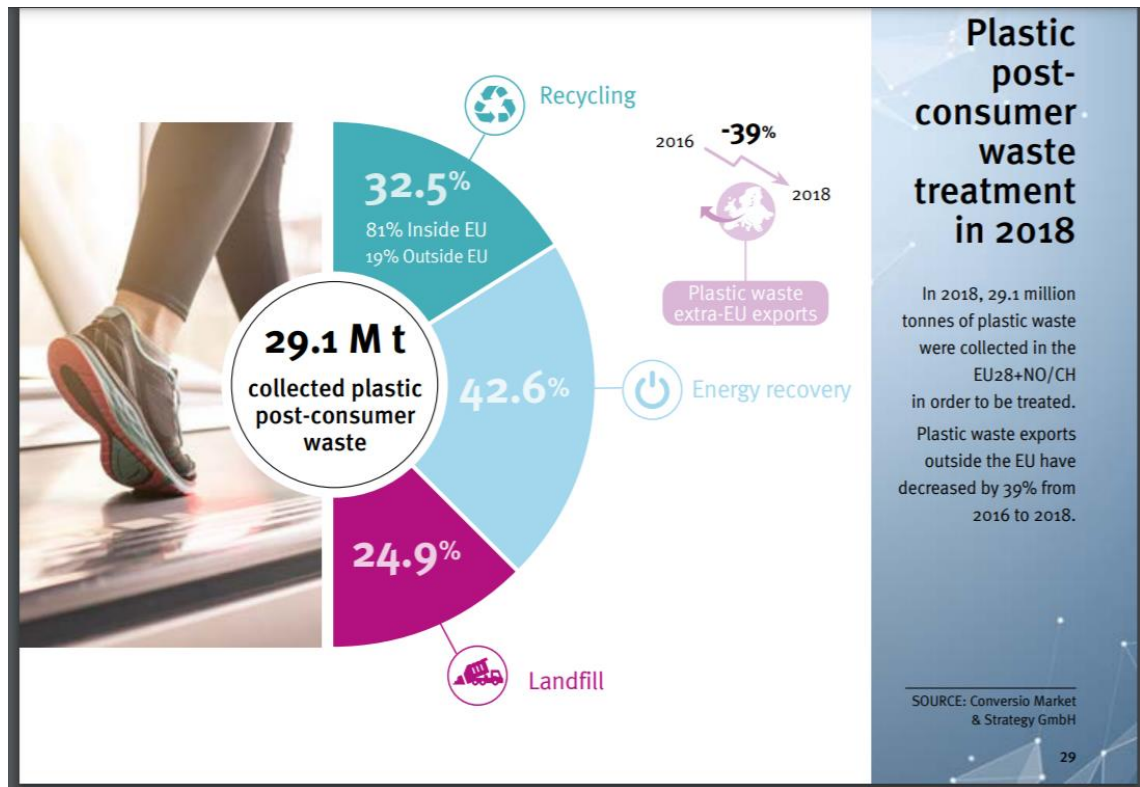


Figure 4: Distribution of post-consumer waste into Landfill, Energy recovery and recycling in 2018 (PlasticsEurope, 2019)

Collected plastic postconsumer waste of more than 29.1 million tonnes in Europe is a tremendous amount. When calculating 32.5% from 29.1 million tonnes it can be indicated that 9.46 million tonnes of plastic waste is indicated to be treated in Europe. However, from this trash already 81% were recycled within Europe and partly recovered. Nevertheless, 19% of this section is sent as waste export to lesser developed countries which accounts to 1.8 million tonnes annually. (PlasticsEurope, 2019)

Of the 1.8 million tonnes of trash that is sent abroad, Germany is the top European exporter with over 400.000 tonnes of plastic trash as seen in figure 5. Since 2019, there has been no major interruption regarding the discarding of plastic scrap in Germany only the distribution and destination has changed during this period of time (Spiegel, 2021).

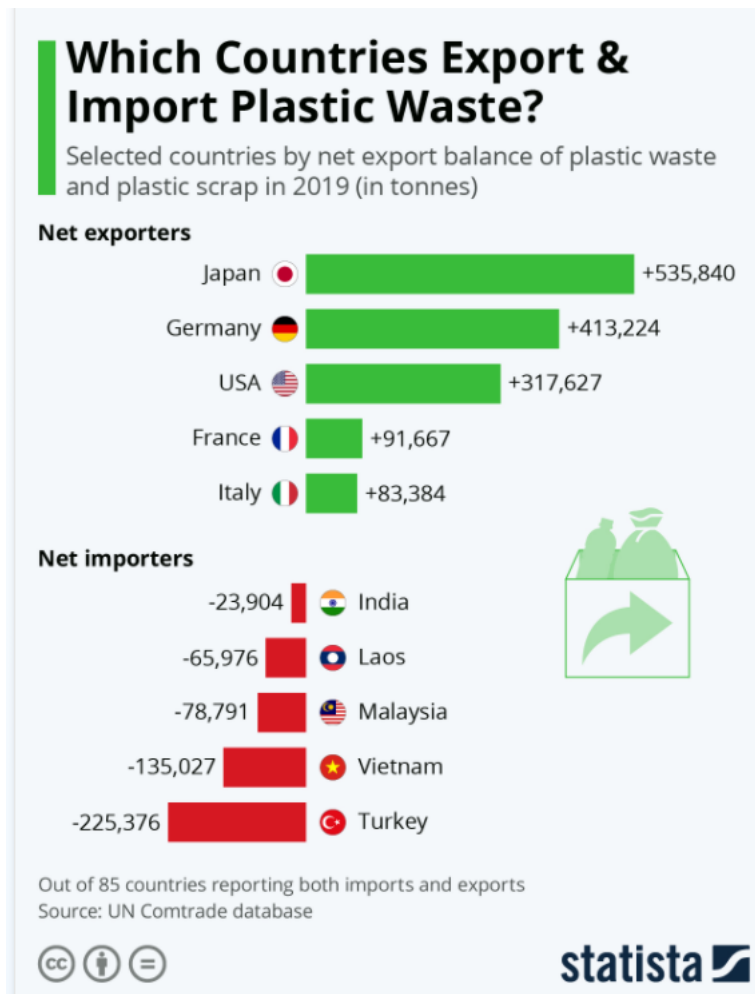


Figure 5: Distribution of largest importers and exporters of plastic waste around the world in 2019 (Statista, 2020)

Most of the plastic trash is exported from developed countries to developing countries, which are already struggling with their own plastic waste. Usually, these countries do not have adequate environmental policies installed which makes it attractive for developed countries to export their scrap there since it is more expensive to treat trash in their home country. A developed country can generally be defined by a relatively high level of economic growth and overall security. Other major indicator for this definition are high income per capita or level of industrialisation (Investopedia, 2020).

Developing countries on the other hand are facing a moderate standard of living, medium/low per capita income level and a slow rate of industrialisation. Other indicators for the division between developed and developing countries are a higher unemployment rate, lower standard of living, higher mortality rate and other factors. (Difference, 2019)

International environmental organizations are eager to support local organisations and individuals in these countries to install better environmental laws to save the environment since inadequate trash disposal in most developing countries ends up in oceans and is one of the major issues currently.

In the past, plastic waste had been mainly exported to China. However, in 2018, China enacted their “National Sword” strategy (CET, 2018) which banned the import of most plastic scrap. This ban was implemented to stop the many contaminated materials that were overwhelming China’s recycling facilities and damaging the environment. Trash started to pile up in Europe and European countries had to find new destinations to export their excess scrap (Katz, 2019).

As shown in figure 6, Malaysia, Vietnam, and Turkey have become the top three destinations for European waste exports (Doyle, 2018).

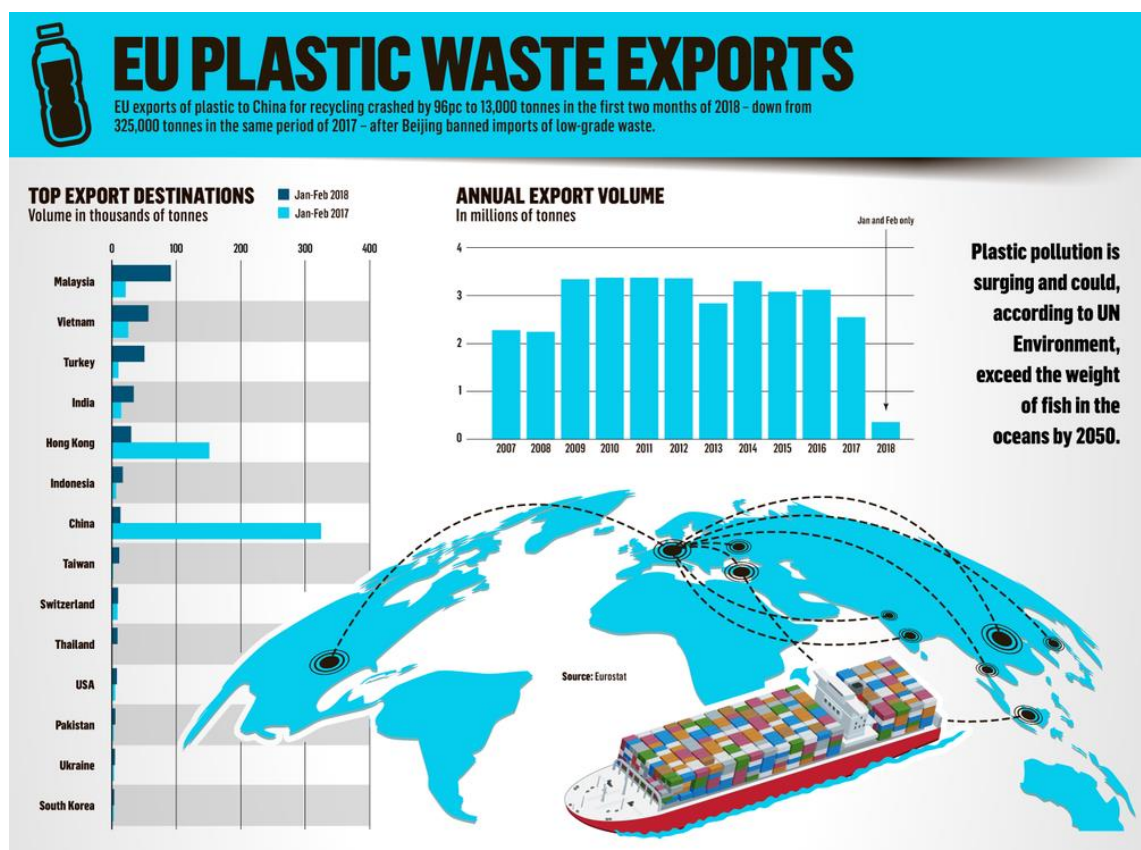


Figure 6. EU plastic waste exports 2017-2018 (Doyle 2018)

In addition, these countries are also experiencing a higher demand for consumer plastics on their national market, which leads to a higher amount of plastic in their waste system. These countries are not equipped to handle such a high quantity of trash. A study from Boucher and Firrot (2017, p.28) concludes that China, India, and Southeast Asian countries emit around half of the maritime plastic pollution. This study proves that exporting excess plastic rubbish from developed countries to less-developed-countries makes the global waste problem even more problematic. The European Union is aware of the challenges and is implementing policies for the export of plastic trash to foreign countries.

#### 4.2. Growing GDP and increase in plastic consumption

Large economies like the United States, Japan, the UK, and Germany have been greatly benefiting from foreign trade. During the last decade, trade with China increased and plenty of shipping containers filled with consumer goods were imported to the above-mentioned countries. Normally, these containers would return to China empty and the circle of China exporting consumer goods to other countries would start again. Nevertheless, a trade agreement enabled these developed countries to agree to low freight prices with logistic companies since the containers would otherwise have returned to China empty. As an extra bonus these countries got rid of their plastic scrap since China was willing to receive foreign trash in order to transform it into new products. Now, container ships with plastic scrap from developed countries must find other destinations to unload their trash mainly in Southeast Asia. Normally, the empty containers return to China to be filled with consumer goods and then return to the above-mentioned countries to start the cycle again. (O'Neill, 2018)

When a country's economy grows and its population increases its purchasing power, there will be a higher demand for products. Along with this increase of consumer products, the pollution of plastic trash surges. Developed countries have responded to this with higher investments in waste management systems. This has led to recycling, incineration, landfills, or the option of exporting this excess trash. Exporting plastic trash from typically high-income countries to less developed countries is problematic. Exporting large amounts of plastics elsewhere encourages consumers in these countries to consume even more plastic because there is no visual evidence of the accumulation of trash. Lower income countries are suffering from massive environmental pollution and

health problems caused by inhaling plastic fumes while burning the trash they cannot process. The sociological impacts should not be neglected when communities become the “trash bin” of the world (Barnes, 2019).

As can be seen in figure 7, projected waste generation by income group, the lower-middle income groups are experiencing the highest growth in waste production. Lower-Middle income countries which are stationed mainly in Sub-Saharan Africa and Asia are going to experience a higher population growth and will thereby emit more trash in the future since economic development is heavily linked to material consumption in these developing countries. As can be seen in the lower part of figure 7 the high-income countries are still producing the most waste per capita per day. (World Bank Report 2018, p. 28)

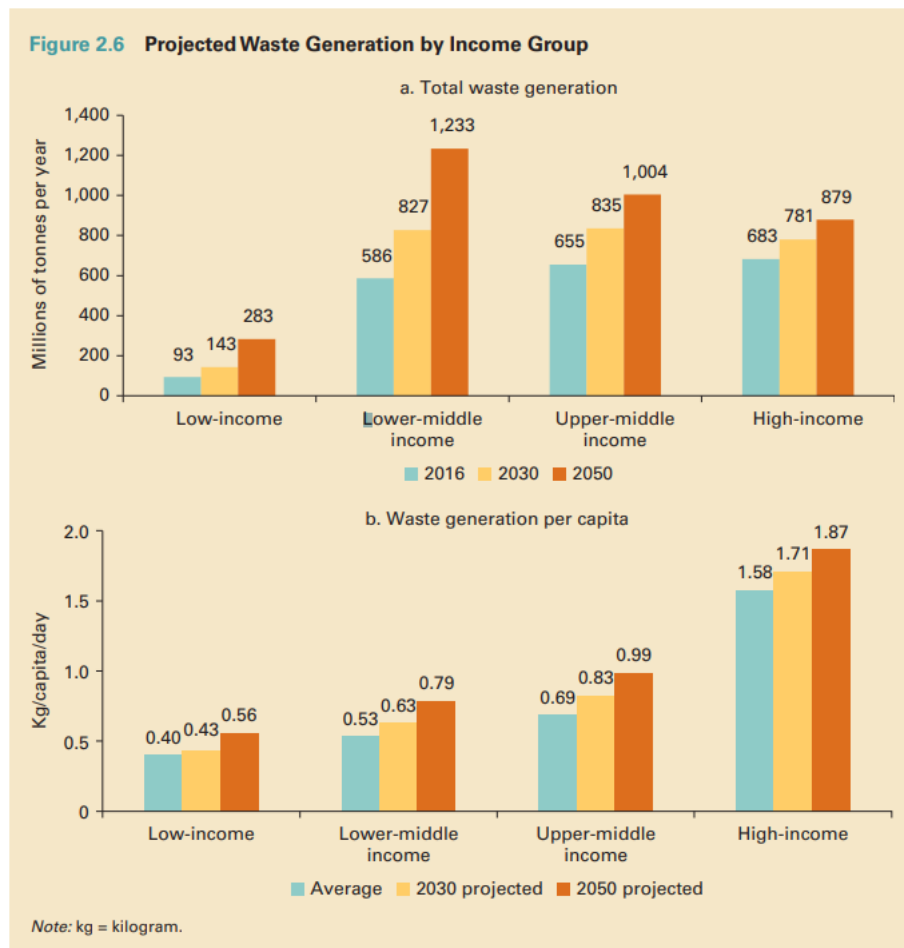


Figure 7. Projected waste generation by income classes (World Bank report 2018, p. 27)

With plastic consumption predictions, as mentioned in the World Bank report, several socio economic and environmental problems will occur if plastic consumption is not addressed correctly. Industries, individuals, and political agendas must address plastic pollution as a threat to humankind if the aim is to succeed in solving the urgent problems humankind has created.

#### 4.3. Recycling and export of plastic scrap in Germany

Since Germany is the largest plastic waste exporter in the European Union, it serves as a case study for further analysis (Cwienk, 2019). Germany established a variety of plastic recycling systems in every federal state and on a national level. On the national level, the PET bottles have a return system. Consumers pay a 25-cent-deposit for every bottle purchased and receives this money back upon returning the bottle. However, this system is valid only for the easily recyclable PET bottles. For other consumer plastic waste, Germany established the “gruener punkt” (green dot) system in 1990 (Fromlowitz, 2019). This system has been the model for the European recycling system. Every product labelled with this dot is recyclable and thereby easy to discard for the consumer. All plastic material, no matter the origin, goes into a specially designated plastic bag and is collected throughout the community.

The collected plastic trash described above accumulates at a waste collection point and is roughly sorted there. After this basic sortation it is separated again by the most distinguishable features of the plastics. There is plastic trash like PET containers, soap containers, LDPE plastics like vitamin pill containers or some plastic bags. Other groups are PVC like cordial, juice or squeeze bottles, PP with lunch boxes, takeout food containers and ice cream containers or PS which is mainly found in foam drinking cups, plastic cutlery, containers, and yoghurts. Half of these materials are easy to recycle, but the other half is mainly trash and is thereby sent to be incinerated in Germany. On the contrary, in other countries the trash is transported into landfills or used for other projects like trash to gas projects which burn the excess plastic and use chemical procedures to produce hydrogen and diesel (Sierra Energy, 2020).

When there is enough HDPE material, it is compressed into a big cube and then stored in containers. These containers are exported to other countries where it is sorted and

recycled by local workers, who are part of a much cheaper labour force than in Germany. (Wang et al., 2020)

The latest data shows that the plastic trash export has decreased by 10% when comparing 2019 and 2020 (Spiegel, 2021). In 2020, 986.000 tonnes were exported to foreign countries, which is roughly 1/6 of all the plastic scrap collected in Germany. The top destinations for German plastic trash have been Malaysia with 151.000 tonnes, which is roughly 32.000 tonnes less than 2019, followed by the Netherlands with 142.000 tonnes, which is roughly the same amount as 2019. The third destination with the highest amount of plastic rubbish from Germany is Turkey, which received 50% more in 2020 than in 2019. With 132.000 tonnes Turkey reached a peak of plastic imports from Germany and has experienced similar growth rates since 2017 even as local politicians have addressed the urgency of inappropriate handling of plastic scrap in Turkey. Countries which have also received at least 50.000 tonnes of rubbish, are Poland, Hong Kong, Austria, and Indonesia. Germany has paid countries 249 € per tonnes of plastic garbage being exported to their country. (RND, 2021)

However, Germany is not only exporting plastic scrap to other countries. It also imports trash from foreign countries and received 479.000 tonnes in 2020. However, this is 13% less than in 2019. Germany received 262€ per tonnes from foreign countries for every ton imported to Germany. (RND, 2021)

## **5. Imported plastic problem in Asia**

### **5.1. Recent history of plastic imports to Southeast Asia**

When analysing the time between 2010 – 2018, when China was importing foreign plastic trash, it can be said that China and Hong Kong imported nearly 90 % of all the global plastic scrap. China produced all kinds of goods of these and gained so materials of the western world. During this time, 12.3 million metric tonnes were imported. This is equivalent to 2.31 million TEU. These 20-foot standard containers can take up to 10 lb/ft<sup>3</sup> of plastic scrap each. (Jan Dell, 2019)

On the other hand, the European Union exported almost all its plastic trash to China before 2018 and accounted approximately 2.75 million tonnes per year to the rubbish

problem in Asia as was shown in figure 6. During those more than eight years when foreign trash was imported to China it had time to establish a recycling infrastructure to handle this excess scrap. However, due to the rising middle class in China, the production of local trash also surged dramatically during the same time. According to a report of the World Bank (Source 2018) China has also been the leading country in mismanaging trash. This explains the urgency why China has rapidly decided to close its borders for almost all foreign plastic scrap imports. China is still importing trash but is allowing only highly sorted trash to enter the country. Many nations are not able to achieve this high level of purity and are therefore forced to export their rubbish to countries, which have less tight restrictions on the sortation level of trash. These countries are e.g., Malaysia, Vietnam, and Turkey. (Doyle, 2018)

## 5.2. Current development of environmental regulations in Asia

When China sent a note to the World Trade Organisation (WTO) in July 2017 stating that it will reduce the intake of plastic from other nations, not everyone expected the country to be so strict. Since January 2018, there have been tighter controls and the plastic trash that does not meet Chinese government regulations is sent back to the exporting country. These new regulations are so strict that it is almost impossible to reach the required level of sortation to export the plastic waste to China. In March 2018, China additionally announced that it will impose a stricter contamination standard for trash imports of 0.05%, which was much lower than the previous 1.5%. This standard means that only 0.05% of trash may deviate from contamination level set by the authorities otherwise it will be sent back (Katz, 2019).

After the changes in China, countries like the US, Japan and Germany were struggling to get rid of their excess plastic trash. These countries shifted their plastic trash export to countries like Thailand, Vietnam, Malaysia, Indonesia, India, and Turkey, which have lower environmental restrictions. These countries were not prepared for such a vast amount of imported trash. As a result, illegal recycling facilities and black-market structures evolved. To combat this situation, the Malaysian government announced in August 2018 a three-month freeze on plastic waste permits to foreign countries. During that same month, Thailand announced that it will ban 432 types of electronic scrap during the next six months. Shortly thereafter, Malaysia took further steps and announced that it will reduce the import of foreign trash within three years. Several countries followed



Malaysia's example. Thailand announced that in 2021 it will permanently ban plastic imports. India has also announced that it will ban all plastic scrap imports and officials in Vietnam published a document that states that no imports of plastic scrap will be permitted after 2025. (The Economist, 2019)

Whereas Southeast Asian countries have been in the news most recently, Turkey has been flying under the radar in matters of public awareness. At the end of 2018 Turkey has become the 8<sup>th</sup> largest plastic scrap importer globally with 436.000 tonnes of waste imported into the country compared to 104.000 tonnes in 2015. According to a report of the Organisation of Economic Co-operation and Development (OECD) 2018, Turkey has sent only 1% of its own waste to recycling centres. Only Chile and Turkey have become worse in recycling since 2000, Chile with a 33 % and Turkey with a 78 % decline in waste recycling rates. (ipa news, 2019)

International organisations like the World Wildlife Fund (WWF) and the Nature and Biodiversity Conservation Union (NABU) are aware of the global problems concerning plastics. They have been working closely with local non-profit organisations (NPO) and active local citizens to address pollution issues to governments in an attempt to change their behaviour. This has worked well in South-East Asian countries like Malaysia, Thailand and Vietnam but has so far failed to be successful in Turkey. Together with countries like Egypt and Italy, Turkey has been responsible for two-thirds of plastic leakage into the Mediterranean Sea (WWF,2019, p.20) When the government of Turkey became aware of this development, it announced a "Zero Waste" campaign aimed at reducing the trash that Turkish citizens are emitting. With over 26.000 institutions and more than 2 million people being educated about the zero-waste project, Turkey aims to encourage its citizens to reduce their trash. This system was introduced in June 2019 and its goal is to reduce non-recyclable waste all over the country. (Bir, 2019)

### 5.3. Local recycling facilities

The normal procedure of shipping and import of waste starts from China where containers are filled with consumer goods exported to developed countries in Europe, in the United States and elsewhere in the world. After the consumer goods are unloaded, the containers would normally go back to China almost empty since Europe has a negative export balance with China. This means that they import more than they export.

(Eurostat, 2019) Shipping lines are offering deals to avoid returning containers to Asia empty since that would have a negative impact on their profitability (O'Neill, 2018). On the way back, the containers get filled with scrap from these countries and send to China until 2018 and since then to other mainly Southeast Asian countries.

When foreign trash arrives in Southeast Asian countries, it is usually handled by several middlemen. First, it arrives at the port and then an official waste distributor picks up the waste from there and sells it to a local distributor. The distributor takes the containers of trash and drives them across the country to the municipalities that are willing to employ waste sorters. They sort the plastic scrap for a relatively small salary. Many Malaysian communities are happy to receive the plastic scrap from other parts of the world because it is economically profitable. It provides a guaranteed income for people who would otherwise not have employment. In some cases, the import of plastic waste is subsidized (Parveen, 2018) and provides a direct source of income in the form of a subsidiary for families or municipalities in the receiving country. In other cases, the waste can provide a resalable resource. (Velis, 2014)

When trash distribution reached its tipping point in 2018, Malaysia was becoming the largest importer of plastic trash from developed countries. Local environmentalists, international organisations, like the WWF and Greenpeace began protesting. These groups have been addressing the poor handling of trash sorting in Malaysia as well as the high level of pollution that the country is emitting into the ocean. (Ibrahim & Noordin, 2020)

#### 5.4. Future opportunities and threats of plastic pollution globally

Several studies show that if plastic pollution of the oceans continues its current path, by 2050 there will be more plastic trash in the oceans than living fish stock (Chan, 2016). As mentioned previously in this paper, Southeast Asia and Sub-Saharan Africa will experience double or triple times the current economic development and urbanization in the next three decades (World Bank report, 2018). This goes hand in hand with plastic consumption and thereby produces a big problem since these countries are poorly prepared for this excess of trash at the moment. In figure 8, numbers from 2016 provide the reference point to the future. Also, other indicators of the World Bank like future population predictions, predicted GDP per capita and other factors have been taken into

consideration in the world bank report mentioned here in projecting the waste generation of every region. It is crucial to understand which areas are the most important once to focus on to reach the highest impact.

As can be seen in figure 8, Asia has become the biggest market of consuming and producing plastic waste, which is predicted to grow substantially. From 2013 to 2015 plastic production increased from 114 to 131 Metric tonnes (Liu., 2018). Next to China, which is producing the most plastic and thereby plastic scrap, India is the second largest consumer of plastic. Even though, India's plastic consumption is just 12 kg/person/year which is equal to 1/10 of an average American household or 1/3 of a Chinese household, India will increase plastic consumption more than threefold in the next decades (Indian Council for Research on International Economic Relations, 2018). Urbanization and a rapid growth of GDP in India is predicted to play a major role in the plastic consumption and trash generation. Moreover, studies of the Ministry of Environment in India found out that 50-60% of plastic consumption is transformed into trash. (Gupta et al, 2015)

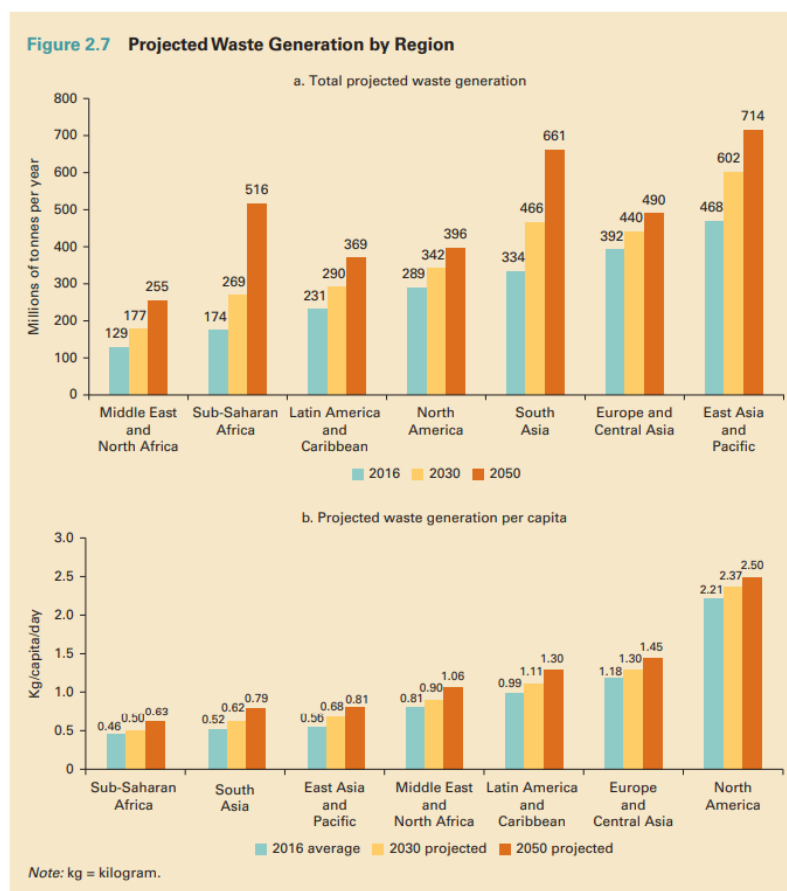


Figure 8. Projected waste generation from 2016 to 2050 by regions globally (World Bank report 2018, p.28)

High-income regions like North America, Europe and central Asia are also experiencing an increase in consumer plastics but these increases are more continuous and not as rapid as in South Asia and Sub-Saharan Africa. Nevertheless, figure 8 shows only the general production of trash, which is divided into organic waste, paper and cardboard, plastics, and others. The European Union wants is tackling this post-consumption trash problem by establishing a circular economy (European Commission, 2020).

When establishing a circular economy not only is less one-way plastic produced, but it also encourages producers to design products that are following the needs of consumers. In addition, the EU has already acted by creating and signing the Basel convention, which is an agreement between 186 states and the European Union. This treaty regulates the movement of hazardous waste from developed countries to LDC's. This convention was established in 1989 and it entered into force in May 1992. Since then, the treaty has been used by several LDC's to return incorrect and hazardous trash back to the country of origin. The treaty includes conditions on import and export of waste including noticing and tracking of waste over national borders. (Basel Convention, 2019)

Furthermore, figure 9 describes how our global plastic consumption is predicted to change from now until 2030. This is illustrated by three scenarios in which the amount of plastic emission in million tonnes is shown on the Y axis compared to the years on the X axis.

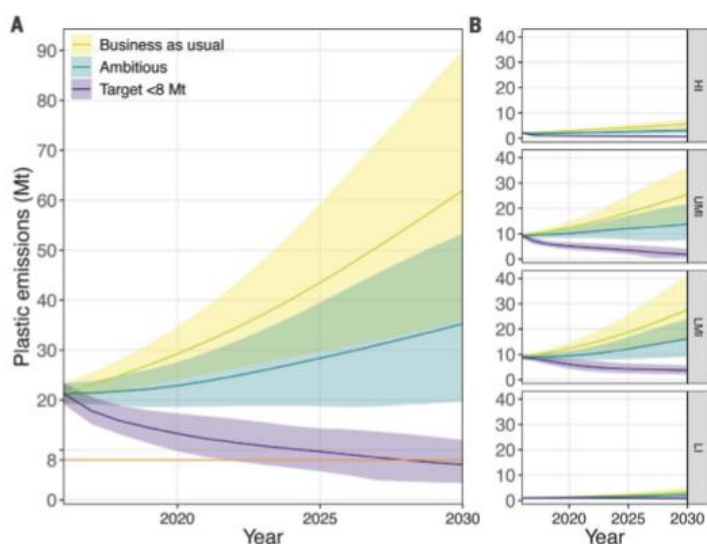


Figure 9. Possible scenarios of plastic waste emissions (World Bank report, 2019)

If production and consumption of plastic develops as usual without any restrictions, in 2030 the amount of plastic produced can be between 50 and 90 million tonnes of plastic as shown in yellow in figure 9. Looking at more ambitious targets, which are marked in green and blue, consumption can be roughly minimized between 20 and 50 million tonnes of plastic emissions. The third curve is showing a target of less than 8 million tonnes of emissions globally which would be the best scenario. As can be seen in figure 9 on the right hand side, the production of emissions is mainly divided between low-middle-class-income and upper-middle-income groups.

Predictions of future waste generation, combined with the knowledge of the harmful impact this future will have on marine life and ultimately human life is leading to global action. Politicians, nations but also individuals are aware of this situation. With combined efforts there is a good chance of finding solutions and ways to create a future with less plastic. The two most promising solutions will be evaluated in chapter 6.

## **6. Alternatives to conventional plastics and ways of coping with the problem**

### **6.1. Bioplastics**

When it comes to suitable alternatives to conventional petrochemical products bioplastics should be considered as a potential candidate. Bioplastic is not just one single material. This word includes a whole family of materials with different attributes. A product can either be biobased, biodegradable or include both attributes.

Biobased does not equal biodegradable. Biobased rather describes the material or product, which is partly derived from organic biomass like corn, sugarcane, or cellulose. Whereas biodegradable describes objects capable of being decomposed by bacteria or other living organisms and thereby avoiding harmful pollution. Since this circumstance is confusing for consumers, the European Union has established the brand “European bioplastics” which is being traded and used in the EU. These European bioplastics have a common standard of biodegradability and need to be certified to be sold. (European Bioplastics, 2020)

According to these standards, all plastics in Europe must be based on renewable resources, biodegradable polymers and must meet all scientific norms for biodegradability and composability. With biotechnology advancing rapidly, areas like biomedicine, energy sector as well as chemical industry can be provided with all sorts of goods based on bioplastic. Most commonly used in the EU is Polylactic Acid (PLA), which is both biodegradable and biocompatible when getting in contact with living tissues. This makes it suitable for implants, sutures, and further medical applications as well as for the food industry since it consumes 25-55% less fossil energy than petroleum-based polymers and can be discarded as biowaste. Main producers of this resource are Ecovio® which is a company owned by BASF in Germany and Solanyl® from the Netherlands. (Jesús, 2019)

So far bioplastics make up only 0.1% of the global plastic market with a volume of 300.000 tonnes per year. This might not seem much but compared to nearly no buyers 10 years ago and a surge in demand within the last two years, this product has high potential. On the other hand, scepticism has been present when it comes to the question of bioplastics taking up too much agricultural surface so that food prices will increase. This argument is mainly incorrect since bioplastics are mostly made of carbohydrate-rich plant parts such as corn or sugar, which are sometimes leftover of conventional farming. Nevertheless, the resources which are not a secondary by-product of farming are only taking up 0.02% of the global agricultural space, which is small compared to sugarcane, corn, and rice, which are accounting to more than 60 % of the global production and land usage. (FAO, 2020)

Bioplastic components are projected to grow on an annual basis of more than 25 %, which will make this resource very valuable and a possible solution to our global plastic problem (Messer, 2020). Acting now is mandatory to reduce the harmful impact of micro plastics and other plastic particles, which are not just being consumed by human beings but also by the food chain they are consuming. Bioplastics can be a tool to avoid future negative impacts on people and future generations to come but we must be willing to act and invest in this technology now. (Chang, 2013)

## 6.2. Circular economy in Germany and Europe

A circular economy, CE, is a model of production and consumption. It involves sharing, leasing, repairing and the recycling of products that would otherwise be discarded (European Parliament, 2020). CE saves resources since products are repaired and not immediately discarded after usage but also reduces CO<sub>2</sub> emissions since less material has to be extracted for the creation of new products.

With the European consumption average of 14 tonnes of raw material per consumer and a creation of waste of five tonnes annually, it can be said that the current linear economic system is unsuitable for the future. Since the industrial revolution, the linear consumption model has been predominant. With CE, the European Parliament is promoting a more sustainable way of living and encouraging initiatives and programs that embrace these goals. The European investment bank for example is providing 10 billion Euros for projects in the EU which are connected to CE until 2023. All these initiatives and programs are among to reduce plastic consumption, encourage a closed loop product life cycle and increase recycling rates. (European Parliament, 2020)

Germany is joining the efforts of the European Union towards a more circular economy. Since Germany is the biggest economy in Europe it can be said that the transition from a linear economy towards a circular economy and embracing this kind of behaviour would have a major impact on Germany and other nations in Europe. If other nations see that Germany can successfully switch to a CE system then other nations would most likely follow.

The “Circular economy initiative Deutschland” is tackling this issue and tries to be the mediator between businesses, politics, and individuals towards a transition, which is more circular and sustainable. As seen in figure 10, the initiative is broken down into 3 sub-divisions and each division includes experts on their field which are suggesting tactics to achieve set goals. With the traction Work group (WG) of Batteries and Packaging it can be said that an improvement of waste disposal and a longer life cycle of batteries and packaging products wants to be achieved. Batteries are playing a major role in the transformation of mobility in Europe from the conventional petroleum using automobile to electric vehicles. The business model part is providing a more supportive channel to improve and help individuals engaged in topics such as industry, science, and

civil society to implement business practices for advancing a circular economy. (Circular economy initiative Deutschland, 2021)

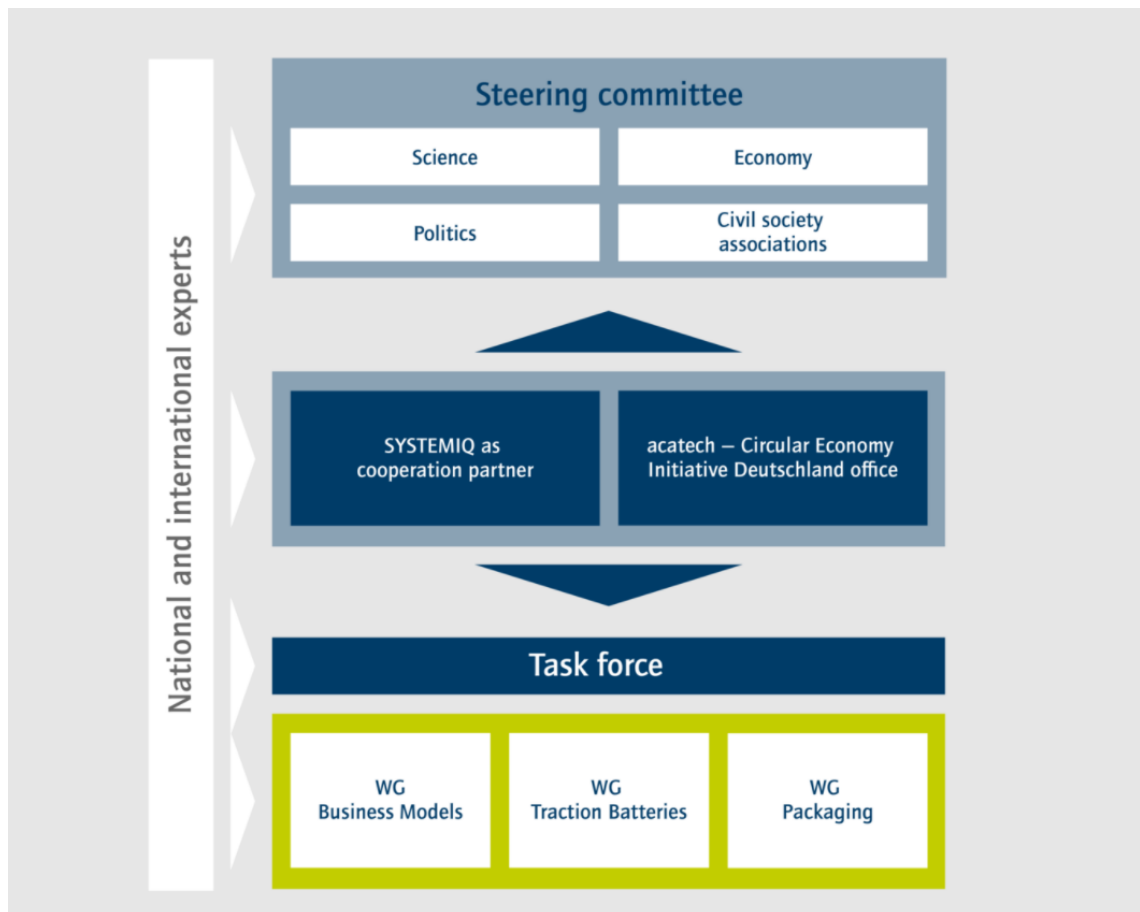


Figure 10. Overall structure of Circular economy Initiative Deutschland (Circular economy initiative Deutschland, 2021)

Since electro mobility is perceived to be the future, the German ministry of education and research is funding studies, which show how important it is to recycle and establish a closed loop model for batteries to reduce the carbon footprint of electric vehicles. If the research in the above-mentioned studies is to be believed, an established closed loop infrastructure in Germany would give the economy higher independence from countries which are selling raw materials for batteries. (Circular economy initiative Deutschland, 2021)



## 7. Conclusions

The hypothesis of this thesis was that "Waste disposal and recycling of plastics in Germany and the export of excess plastic waste from Germany to Asian countries can be more ethical in the future and yet successful in trade terms to both parties".

In the current situation the plastic waste trade between exporting developed countries and importing developing countries is not ethical nor sustainable. Germany is still the largest plastic waste exporting country in Europe and sends the excess scrap to Southeast Asian countries. With efforts to reduce this amount, the German government has made the right steps with system of returning PET bottles and other initiatives which address recycling directly in the country.

These importing countries emit the highest amount of plastic scrap into nature as shown in the WWF report (WWF, 2019, p.20). This is a direct impact of the inability of these countries to handle excess scrap from abroad. To make this system equal and beneficial for both parties it would take more efforts of both parties in matters of supporting each other. Exporting countries would need to compensate these importing countries more, invest into their recycling infrastructure and overall, a more sustainable consumer model in the exporting country should be incorporated to reduce the plastic waste at the source.

The current linear economy in Germany is forcing the country, due to profit maximisation and economic structures, to send plastic scrap from Germany to developing countries mainly in Southeast Asia because labour is cheaper there and both nations benefit from this kind of trade. Germany is getting rid of their excess plastic trash while developing countries receive a payment per ton of waste and acquire valuable resources if recycled properly. This goes hand in hand with the theoretical framework of Adam Smith who says an effective division of labour is bringing benefits to both nations as was discussed in chapter 2.

The import restrictions of China regarding plastic waste imports have impacted the global plastic industry heavily. Developed countries including Germany must find other countries to export their excess plastic scrap to. Nevertheless, the route the trash has made earlier from countries with higher income to countries with lower income stays however intact only the countries involved have changed. Southeast Asian countries are now the countries receiving all this trash and struggle with it. This change has brought a

certain imbalance, but the free market found a way to handle the situation even though environmental issues are not regarded there.

With some materials like PET, HDPE, and LDPE, which are easy to recycle, there is also an abundance of other materials, that Germany is exporting to these countries which are not recycled, ending up in landfills, oceans or being burned. Facilities in these developing countries are not able to handle the excess scrap coming from overseas, which is the reason for these countries being the source of the highest maritime pollution of plastic scrap in the world (WWF, 2019, p.20). Moreover, communities in Southeast Asia which are receiving the plastic scrap gain a save income but endanger their health, environment, and nation negatively since they are seen as the “trash bin” of the world (Barnes, 2019).

Since Africa and Asia are predicted to double or triple their plastic consumption until 2050, it is mandatory to establish plans and international rules, which everyone must follow. Germany which is not affected by an exponentially growing population in the next decades is nevertheless predicted to increase their plastic outcome according to the world bank report of 2018. Germany and the European Union in general need to establish rules and guidelines which are regulating these commodities. The European Union is working towards a more sustainable future and circular economy is one of the tools to achieve these goals.

According to the European Parliament, countries have to encourage a more circular economy system in their nation. With commitments included in the circular economy initiative several issues are to be tackled such as increase electronic waste recycling, minimize packaging waste and ambitions to reduce soil sealing in the construction industry. These are important first steps to achieve a sustainable and self-sufficient economy in Europe by 2050. (European Commission, 2020) When looking at an individual level, every consumer can do things to support this movement. Buying more reusable products like glass bottles and cotton bags and consuming products, which are made in the home country, is helping this system to work. It will require strong cooperation between all shareholders on a local, national, and international level but in failing to do so, the impacts on our environment will be even more severe than they are already. (European Commission, 2020)

Circular Economy on the one hand could save our environment and vulnerable ecosystems like our oceans. It could provide the EU with an opportunity to be independent from other nations especially now since trade disputes have increased in 2020/2021 and being less dependent on other nations is crucial. On the other hand, there must be great investments into a circular economy infrastructure from refill stations for shampoo containers to more repair shops all over the country. Another big responsibility is to create an awareness in the population to encourage CE since without consumers and a collective aim to achieve such a future, this endeavour is doomed to fail. (Ledsham, 2020)

Nevertheless, not only politicians have to work towards a greener and better future, but also big companies, which are producing the petrochemical plastics and processing this material, must switch to less harmful products and thereby encourage research in bioplastics and other suitable solutions. It is important to create consumer goods, which are less harmful for the environment, to create proper recycle infrastructure in Europe and Asia as well as increase conscious re-evaluation whether everything needs to be packed in plastics.

With the European bioplastic initiative, there has already been a big step towards the right future. Since bioplastics are very diverse, different sectors will be able to use this resource. Medicine, energy sector and the packaging industry are already experimenting and integrating this resource in their product portfolio. With the predictions made in this paper, bioplastics around the world will experience a surge in demand in the next decade and will eventually overtake the petroleum-based plastics. Circular economy at the same time will make its part to reduce people's linear consumption model towards a more sustainable model. With initiatives emerging more frequently in the last years my own predictions forecast that public awareness and entrepreneurship within the European Union and globally will tackle this issue but are mainly lagging the political support they need to create the maximum efficiency.

An evaluation of the plastic trade before 2018 can be made rather confidently but it becomes harder when analysing the distribution of plastic scrap all-over Southeast Asia. There are many different states involved some of which have a communistic government structure such as Vietnam and data available from these countries should be evaluated more carefully. However, also more democratic states could be whitewashing their data or manipulate it to create a better image of themselves. Nevertheless it is reliable to claim

based on plenty of research made in this thesis, that Southeast Asian countries are going to be the main importer of excess scrap from DC's and this will not change within the next few years.

Although the thesis examines the history of sending plastic scrap from Germany to Asia, it can be said that international organisations and political influence has only been evaluated vaguely and with this being said, further research on their impact has to be conducted. Moreover, technological, and legal structures were only mentioned roughly here and deserve more importance in future research on this topic.

## References

AAA Polymer, 2020. *PET vs LDPE vs HDPE PCR Resin: Benefits and Applications of Each Type*. [online] Available at: <<https://www.aaapolymer.com/pet-vs-ldpe-vs-hdpe-pcr-resin/>> [Last accessed 9 February 2021].

Alpla, 2021. *ALPLA IS A WORLD LEADER IN THE DEVELOPMENT AND PRODUCTION OF PLASTIC PACKAGING SOLUTIONS*. [online] Available at: <<https://www.alpla.com/en>> [Last accessed 3 May 2021].

Ambrose, 2019. *War on plastic waste faces setback as cost of recycled material soars*. [online] Available at: <<https://www.theguardian.com/environment/2019/oct/13/war-on-plastic-waste-faces-setback-as-cost-of-recycled-material-soars>> [Last accessed 3 May 2021].

Anderton C.H., 1995. *Chapter 18 Economics of arms trade*. Page 523-561, Elsevier. [online] Available at: <[https://doi.org/10.1016/S1574-0013\(05\)80020-1](https://doi.org/10.1016/S1574-0013(05)80020-1)> [Last accessed 30 April 2021].

Averagesalarysurvey, 2021. *Average Salary / Countries*. [online] Available at: <<https://www.averagesalarysurvey.com/>> [Last accessed 27 April 2021].

Barnes Stuart J., 2019. *Out of sight, out of mind: Plastic waste exports, psychological distance and consumer plastic purchasing*. Elsevier, United Kingdom.

Basel Convention, 2019. *Basel Convention & Basel Protocol on Liability and Compensation*. [online] Available at: <http://www.basel.int/TheConvention/Overview/TextoftheConvention/tabid/1275/Default.aspx> [Last accessed 7 October 2020].

Better Meets Reality, 2019. *The Reasons Why Some Plastic Can't Be Recycled*. [online] Available at: <<https://bettermeetsreality.com/reasons-why-some-plastic-cant-be-recycled/>> [Last accessed 5 March 2021].

Bir Burak, 2019. *Turkey's regulation aims to stem waste, not recycle*. [online] Available at: <<https://www.aa.com.tr/en/environment/turkeys-regulation-aims-to-stem-waste-not-recycle/1638794>> [Last accessed 18 October 2020].

BizVibe, 2020. *What Is the Current State of the Plastic Products Industry?* . [online] Available at: <<https://blog.bizvibe.com/blog/plastic-manufacturing-companies>> [Last accessed 9 February 2021].

Boucher, J., Friot, D., 2017. *Primary microplastics in the oceans. A Global Evaluation of Sources*. International Union for Conservation of Nature and Natural Resources (IUCN), Gland, Switzerland.

Cambridge Dictionary, 2021. *Plastic*. [online] Available at: <<https://dictionary.cambridge.org/us/dictionary/english/plastic>> [Last accessed 13 April 2021].

CET Center for Ecotechnology. *What is the National Sword?* [online] Available at: <<https://www.centerforecotechnology.org/what-is-the-national-sword/>> [Last accessed 17 October 2020].

Chan Melissa, 2016. *Oceans Will Have More Plastic Than Fish By 2050, Study Says*. [online] Available at: <<https://time.com/4186250/ocean-plastic-fish/>> [Last accessed 18 October 2020].

Chang et al. 2016. *Impact of China's Recycling Subsidy Policy in the Product Life Cycle*. [online] Available at: <[https://www.researchgate.net/publication/306244635\\_Impact\\_of\\_China's\\_Recycling\\_Subsidy\\_Policy\\_in\\_the\\_Product\\_Life\\_Cycle](https://www.researchgate.net/publication/306244635_Impact_of_China's_Recycling_Subsidy_Policy_in_the_Product_Life_Cycle)> [Last accessed 30 April 2021].

Chang M., 2019. *Microplastics in Facial Exfoliating Cleansers*. [online] Available at: <[https://nature.berkeley.edu/classes/es196/projects/2013final/ChangM\\_2013.pdf](https://nature.berkeley.edu/classes/es196/projects/2013final/ChangM_2013.pdf)> > [Last accessed 18 February 2021].

Circular economy initiative Deutschland, 2021. *Circular Economy A WAY FORWARD*. [online] Available at: <<https://www.circular-economy-initiative.de/english>> [Last accessed 21 February 2021].

Cwienk Jeannette, 2019. *German plastic floods Southeast Asia*. [online] Available at: <<https://www.dw.com/en/german-plastic-floods-southeast-asia/a-47204773>> [Last accessed 11 February 2021].

Difference, 2019. *Difference Between Developed Countries and Developing Countries*. [online] Available at: <<https://www.difference.wiki/developed-countries-vs-developing-countries/>> [Last accessed 17 March 2021].

Doyle Alister, 2018. *EU PLASTIC WASTE REPORTS*. [online] Available at: <<https://www.independent.ie/business/world/waste-plastic-piling-up-at-ports-as-shipments-to-china-collapse-36906090.html>> [Last accessed 7 October 2020].

eFinanceManagement, 2021. *International Trade Theory – All You Need to Know*. [online] Available at: <<https://efinancemanagement.com/international-financial-management/international-trade-theory>> [Last accessed 14 April 2021].

European Commission, 2020. *Circular Economy Action Plan*. [online] Available at: <[https://ec.europa.eu/environment/circular-economy/pdf/new\\_circular\\_economy\\_action\\_plan.pdf](https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf)> [Last accessed 21 October 2020].

European Bioplastics, 2020. *What are bioplastics?* [online] Available at: <<https://www.european-bioplastics.org/bioplastics/>> [Last accessed 17 February 2021].

European Parliament, 2020. *Circular economy: definition, importance, and benefits*. [online] Available at: <<https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits>> [Last accessed 18 February 2021].

Eurostat, 2019. *EU-China trade in goods: €185 billion deficit in 2018*. [online] Available at: <<https://ec.europa.eu/eurostat/web/products-eurostat-news/-/EDN-20190409-1>> [Last accessed 18 October 2020].

ExpertsMind, 2020. *Strategic trade theory*. [online] Available at: <<http://www.expertsmind.com/topic/alternative-explanations-of-trade/strategic-trade-theory-93796.aspx>> [Last accessed 30 April 2021].

FAO Food and Agriculture Organisation of the United Nations, 2020. *Value of Agricultural Production*. [online] Available at: <<http://www.fao.org/faostat/en/#data/QV>> [Last accessed 20 October 2020].

Freinkel, 2011. *Plastics: A Toxic Love Story*. New York: Henry Holt, p. 4.

Fromlowitz, 2019. *EU: "Der Grüne Punkt" is not a trademark used for packaged goods*. [online] Available at: <<https://www.hlmediacomms.com/2019/04/23/eu-der-grune-punkt-is-not-a-trademark-used-for-packaged-goods/>> [Last accessed 15 March 2021].

Geyer, R., Jambeck, J.R., Law, K.L., 2017. *Production, use, and fate of all plastics ever*. P. Dauvergne *Global Environmental Change* 51 (2018) 22–31 29 made. *Science Advances* 3 (7) [online] Available at: <<http://dx.doi.org/10.1126/sciadv.1700782>> [Last accessed 23 October 2020].

Government of the Netherlands, 2017. *From a linear to a circular economy*. [online] Available at: <<https://www.government.nl/topics/circular-economy/from-a-linear-to-a-circular-economy>> [Last accessed 5 March 2021].

Gupta N., Krishna KumarYadav, Vinit Kumar, 2015. *A review on current status of municipal solid waste management in India*. *Journal of Environmental Sciences*, Volume 37, 2015, Pages 206-217, ISSN 1001-0742. [online] Available at: <<https://www.sciencedirect.com/science/article/pii/S1001074215002995>> [Last accessed 15 February 2021].

Ibrahim & Noordin, 2020. *Understanding the Issue of Plastic Waste Pollution in Malaysia: A Case for Human Security*. [pdf guide online] Available at: <<https://jmiw.uitm.edu.my/images/Journal/Vol123Paper4.pdf>> [Last accessed 16 February 2021].

Indian Council for Research on International Economic Relations, 2018. *Solid Waste Management in India: An Assessment of Resource Recovery and Environmental Impact*.



[pdf guide online] Available at: <[http://icrier.org/pdf/Working\\_Paper\\_356.pdf](http://icrier.org/pdf/Working_Paper_356.pdf)> [Last accessed 15 February 2021].

Investopedia, 2020. *Developed Economy*. [online] Available at: <<https://www.investopedia.com/terms/d/developed-economy.asp>> [Last accessed 17 March 2021].

Ipa news, 2019. *Turkey becomes one of the biggest plastic waste importers in the world*. [online] Available at: <<https://ipa.news/2019/04/26/turkey-becomes-one-of-the-biggest-plastic-waste-importers-in-the-world/>> [Last accessed 18 October 2020].

Jan Dell, 2019. *157,000 Shipping Containers of U.S. Plastic Waste Exported to Countries with Poor Waste Management in 2018*. [online] Available at: <[https://www.plasticpollutioncoalition.org/blog/2019/3/6/157000-shipping-containers-of-us-plastic-waste-exported-to-countries-with-poor-waste-management-in-2018#\\_ftn1](https://www.plasticpollutioncoalition.org/blog/2019/3/6/157000-shipping-containers-of-us-plastic-waste-exported-to-countries-with-poor-waste-management-in-2018#_ftn1)> [Last accessed 7 October 2020].

Jesús M., 2019. *Biotechnological Processes and Products*. Faculty of Science and Technology, University of the Basque Country, Leioa, Spain.

Katz Cheryl, 2019. *Piling Up: How China's Ban on Importing Waste Has Stalled Global Recycling*. [online] Available at: <<https://e360.yale.edu/features/piling-up-how-chinas-ban-on-importing-waste-has-stalled-global-recycling>> /> [Last accessed 11 February 2021].

Kwong, 2019. *10 FACTS ABOUT PLASTIC WASTE IN SOUTHEAST ASIA*. [online] Available at: <<https://borgenproject.org/10-facts-about-plastic-waste-in-southeast-asia/>> [Last accessed 30 April 2021].

Ledsham, 2020. *Engaging Consumers to Reduce and Recycle*. [online] Available at: <<https://www.sustainability.com/thinking/engaging-consumers-to-reduce-and-recycle/>> [Last accessed 30 April 2021].

Liu C, Progress of the world plastics industry in 2016-2017. China plastics industry. 2018. 46(3):1-12, 32. (in Chinese)

Messer Sarah, 2020. *2020 BIOPLASTICS MARKET FORECAST*. [online] Available at: <<https://greenblue.org/2020-bioplastics-market-forecast/>> [Last accessed 20 October 2020].

Myint, H., 1977. *Adam Smith's Theory of International Trade in the Perspective of Economic Development*. *Economica*, vol. 44, no. 175, 1977, pp. 231–248.

O'Neill, K., 2018. *The new global political economy of waste*. In: Dauvergne, P., Alger, J. (Eds.), *A Research Agenda for Global Environmental Politics*. Edward Elgar, Cheltenham, UK Ch. 7.

Paprotny D., 2021. *D. Convergence Between Developed and Developing Countries: A Centennial Perspective*. [online] Available at: <<https://doi.org/10.1007/s11205-020-02488-4>> [Last accessed 25 April 2021].

Parveen, N., 2018. *UK's Plastic Waste May Be Dumped Overseas Instead of Recycled. 23 July 2018*. [online] Available at: <<https://www.theguardian.com/environment/2018/jul/23/uks-plastic-waste-may-be-dumped-overseas-instead-ofrecycled>> [Last accessed 15 October 2020].

PlasticsEurope, 2017. *Plastics – the Facts 2017* [PDF guide] Available at: <[https://www.plasticseurope.org/application/files/5715/1717/4180/Plastics\\_the\\_facts\\_2017\\_FINAL\\_for\\_website\\_one\\_page.pdf](https://www.plasticseurope.org/application/files/5715/1717/4180/Plastics_the_facts_2017_FINAL_for_website_one_page.pdf)> [Last accessed 15 October 2020].

PlasticsEurope, 2019. *Plastics – the Facts 2016*. [PDF guide] Available at: <[https://www.plasticseurope.org/application/files/1115/7236/4388/FINAL\\_web\\_version\\_Plastics\\_the\\_facts2019\\_14102019.pdf](https://www.plasticseurope.org/application/files/1115/7236/4388/FINAL_web_version_Plastics_the_facts2019_14102019.pdf)> [Last accessed 23 October 2020].

Raleigh, 2020. *Federal Reserve Says China's Economic Numbers Are Just As Garbage As Their COVID Data*. [online] Available at: <<https://thefederalist.com/2020/11/03/federal-reserve-says-chinas-economic-numbers-are-just-as-garbage-as-their-covid-data/>> [Last accessed 25 April 2021].

RND, 2021. *Deutschland exportierte 2020 weniger Plastikmüll ins Ausland*. Berlin: Redaktionsnetzwerk Deutschland, dpa. [online] Available at: <<https://www.rnd.de/wirtschaft/deutschland-exportierte-2020-weniger-plastikmull-ins->

ausland-XOOPAMKOMGBS5GLYGNX2HPPPYA.html> [Last accessed 15 February 2021].

Schmidt Isabell, 2018. *Recycling in Germany: PET bottles setting the trend*. [online] Available at: <<https://newsroom.kunststoffverpackungen.de/en/2018/02/14/recycling-in-germany-pet-bottles-setting-the-trend/>> [Last accessed 10 February 2021].

Shruti, 2019. *Differences in Cost that Forms the Basis of Trade*. [online] Available at: <<https://www.economicdiscussion.net/international-trade/differences-in-cost-that-forms-the-basis-of-trade/11932>> [Last accessed 29 April 2021].

Sierra Energy, 2020. *FastOx® Gasification*. [online] Available at: <<https://sierraenergy.com/technology/fastox-gasification/>> [Last accessed 11 February 2021].

Spiegel, 2021. *Deutschland ist Export-Europameister – beim Plastikmüll*. [online] Available at: <<https://www.spiegel.de/wirtschaft/deutschland-ist-export-europameister-beim-plastikmuell-a-52785ee9-b6dc-4c22-a59b-bcdb48423b32>> [Last accessed 15 March 2021].

Statista, 2020. *PLASTIC WASTE Which Countries Export & Import Plastic Waste?* [online] Available at: <<https://www.statista.com/chart/18229/biggest-exporters-of-plastic-waste-and-scrap/>> [Last accessed 15 March 2021].

The Economist, 2019. *South-East Asian countries are banning imports of waste for recycling*. [online] Available at: <<https://www.economist.com/asia/2019/06/15/south-east-asian-countries-are-banning-imports-of-waste-for-recycling>> [Last accessed 11 February 2021].

Theil Linda, 2016. *Blow Molding Explained - How PET Jars and Containers are Manufactured!* [online] Available at: <<https://parkwayjars.com/blog-1/blow-molding-explained-how-pet-jars-and-containers-are-manufactured/>> [Last accessed 9 February 2021].

United States Environmental Protection Agency, 2021. *New International Requirements for the Export and Import of Plastic Recyclables and Waste*. [online] Available at:

<<https://www.epa.gov/hwgenerators/new-international-requirements-export-and-import-plastic-recyclables-and-waste>> [Last accessed 18 March 2021].

Velis, C., 2014. *Global Recycling Markets: Plastic Waste*. International Solid Waste Association., Vienna.

Wang Chau, Longfeng Zhao, Ming K Lim, Wei-Qiang Chen, John W. Sutherland, 2020. *Structure of the global plastic waste trade network and the impact of China's import Ban, Resources, Conservation and Recycling*, Volume 153, 2020, 104591, ISSN 0921-3449. [online] Available at:

<<https://www.sciencedirect.com/science/article/pii/S0921344919304975>> [Last accessed 11 February 2021].

World bank group, 2018. *WHAT A WASTE 2.0. [PDF guide]* Available at: <<https://olc.worldbank.org/system/files/What%20a%20Waste%202.0%20Overview.pdf>> [Last accessed 23 October 2020].

Writer Staff, 2020. *What Is Strategic Trade Policy?* [online] Available at: <<https://www.reference.com/world-view/strategic-trade-policy-b9d2f076fa028645>> [Last accessed 27 April 2021].

WWF, 2019. *STOP THE FLOOD OF PLASTICS How Mediterranean countries can save their sea*. [online] Available at:<[https://wwfeu.awsassets.panda.org/downloads/wwfmmi\\_stop\\_the\\_flood\\_of\\_plastic\\_mediterranean.pdf](https://wwfeu.awsassets.panda.org/downloads/wwfmmi_stop_the_flood_of_plastic_mediterranean.pdf)> [Last accessed 18 October 2020].