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Impact of COVID-19 on single-use plastics and the environment in Europe

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Authors: Kathrin Graulich, Andreas Köhler, Clara Löw, Jürgen Sutter (Oeko-Institut e.V.), David Watson, Georg Mehlhart, Kia Rose Egebæk (PlanMiljø ApS), Valentijn Bilsen, Federico Bley (IDEA Consult n.V.), Saskia Manshoven (VITO), Arlind Xhelili (CSCP), Lars Fogh Mortensen, Ida Lippert Tange (EEA)

ETC/WMGE consortium partners: Flemish Institute for Technological Research (VITO), CENIA, Collaborating Centre on Sustainable Consumption and Production (CSCP), Research Institute on Sustainable Economic Growth of National Research Council (IRCrES), The Public Waste Agency of Flanders (OVAM), Sustainability, Environmental Economics and Dynamic Studies (SEEDS), VTT Technical Research Centre of Finland, Banson Communications Ireland (BCI), The Wuppertal Institute for Climate, Environment, Energy (WI), Slovak Environment Agency (SEA)

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European Topic Centre on Waste and Materials
in a Green Economy
Boeretang 200
BE-2400 Mol
Tel.: +14 33 59 83
Web: wmge.eionet.europa.eu
Email: etcwmge@vito.be

Contents

Acknowledgements

A draft version of this report was prepared between November 2020 and February 2021 by the following authors, under the guidance of Lars Fogh Mortensen (EEA) and Ida Lippert Tange (EEA):

- Kathrin Graulich, Andreas Köhler, Clara Löw, Jürgen Sutter (Oeko-Institut e.V.)
- David Watson, Georg Mehlhart, Kia Rose Egebæk (PlanMiljø ApS)
- Valentijn Bilsen, Federico Bley (IDEA Consult n.V.)

The following organisations and experts were interviewed to gather their input during the preparation of the report:

- ACR+
- Municipal Waste Europe
- European Plastics Converters
- DECO: Consumer Association Portugal[1]
- Which?: Consumer Association UK[2]
- Eva Gelabert, EEA

On 9th December 2020 and 13th January 2021, two online workshops were organized to present preliminary results and gather feedback and inputs from experts and EEA country representatives through National Reference Centres, National Focal Points, European Topic Centres and the Environmental Protection Agencies' Network interest groups on Waste, Plastics, Resource Efficiency and Green Economy. The names of all participants are included in annex 3.

The resulting draft report was edited and revised into the current ETC/WMGE report by Saskia Manshoven (VITO, ETC/WMGE), with the support of Arlind Xhelili (CSCP, ETC/WMGE), Ive Vanderreydt (VITO, ETC/WMGE) and Lars Fogh Mortensen (EEA).

[1] https://www.deco.proteste.pt/
[2] https://www.which.co.uk/

1 Introduction

In March 2020, the European Commission published the new Circular Economy Action Plan. One of its objectives is to reduce plastic packaging waste and plastic litter, and to implement the Directive on Single-use Plastic (SUP) which aims to reduce the negative impacts on the environment of certain plastic products that are intended to be used one or few times before being discarded (Directive (EU) 2019/904). However, Europe's efforts on reducing impacts of single-use plastics coincides with the global outbreak of the COVID-19 pandemic. The COVID-19 responses, involving lockdowns, social distancing measures and the use of personal protective equipment (PPE), has considerable effects on the use of single-use plastics. At a global level, temporarily interrupted supply chains and production due to the lockdowns and reduced mobility across the world, including in European countries, led to a reduction in oil demand and a decrease of the global oil prices.

This study aims to estimate the effects of the COVID-19 pandemic on the use and environmental impacts of single-use plastics in Europe. The term 'single-use plastic' is used to describe products made of plastics, that are meant to be used once, or for a short period of time, before being thrown away. This study looks at a particular selection of single-use plastic products which use is expected to be influenced by the COVID-19 response.

A very visible and remarkable effect of the guidelines on personal protection was a surge in the demand for protective equipment made of single-use plastics, such as face masks, gloves, gowns, or bottled hand sanitizers – not only in medical environments, but increasingly across society. For other types of single-use plastics, such as packaging and disposable food containers, the overall effect of the pandemic is less clear. As a result of lockdowns in many European countries, many people (temporarily) lost their jobs, more people were obliged to work from home, events and leisure activities were cancelled, shops were closed and travels were restricted. This may have led, on the one hand, to reduced overall consumption and reduced sales of snacks, food and drinks on-the-go, causing a reduced use of associated single-use plastic packaging. On the other hand, since in many countries restaurants and cafés were closed for on-site dining, many businesses were forced to shift towards take-away and food delivery, which potentially increased the use of single-use plastic food containers. Similarly, the closure of shops may, on the one hand, have reduced shopping and associated single-use plastic packaging, while, on the other hand, it gave another boost to e-commerce, which in its turn increases the use of single-use plastic packaging and protective filling materials for mailing purposes.

Some of these effects will probably be temporary and once the pandemic will be under control, practices might return to the pre-COVID trends. However, the pandemic and the responses to it may lead to a change in priority setting between environmental goals and hygienic health considerations, on the short term as well as on the longer term (Simon, 2020; Southey, 2020). In April 2020, plastic industries advocated reconsidering or postponing the ambitions on plastic reduction in view of the extraordinary circumstances and the benefits of 'single-use' products in terms of hygiene and protection against virus spread (European Plastics Converters, 2020). While the European Commission has held on to its ambitions regarding the reduction and ban on single-use plastics (Simon, 2020), a continuation of the pandemic situation in the longer term, could potentially affect the realization of the EU's goal of reducing the use and impacts of single-use plastics.

It is important to highlight that this report does not aim to assess the effectiveness or ambitions of the Single-use plastics Directive. While some of the products in scope of this study are mentioned in the context of the Single-use Plastic Directive (e.g. food containers), others are not (e.g. medical protective equipment). Similarly, not all single-use plastic products mentioned in the Single-Use Plastic Directive are expected to be directly influenced by the COVID-19 response and, as a consequence, are not discussed in this report. The analysis focuses on synthetic single-use medical protection equipment such as face masks and gloves, and on single-use plastic packaging for e-commerce and food services (take-away and delivery). Even though it can be expected that the effects of the pandemic go broader, this selection was made based on the most obvious perceived direct changes in single-use plastic consumption and on the availability of data for the period April-September 2020. In view of the recent nature of these events and trends, data availability was very limited, suggesting that an update and complement of these findings at a later stage could be considered.

In chapter 2, the effects of the COVID-19 pandemic are estimated on the consumption, production and trade of single-use plastics during the first wave of the pandemic in Europe (April-September 2020). Chapter 3 calculates the environmental and climate impacts associated with these effects. In chapter 4, the study makes a first reflection on possible implications and options for addressing the impacts of the COVID-19 pandemic on the use of single-use plastic , including policy options, circular business models and consumer initiatives. Chapter 5 provides a summary of the finding and some further reflections.

2 Effects of the COVID-19 pandemic on consumption, production and trade of single-use plastics in Europe

2.1 What are single-use plastics?

Simply put, single-use plastic products are products made of plastics, that are meant to be used once, or for a short period of time, before being thrown away. Examples are straws, disposable drinking cups, food and beverage containers, sanitary towels and all kinds of packets and wrappers. Single-use plastics have gained attention at the EU-level because of their large share in plastic pollution and marine litter. Alongside fishing gear, the 10 most commonly found single-use plastic items on European beaches represent 70% of all marine litter in the EU (European Commission, 2019). In order to fight marine litter and reduce the impact of plastics on the environment, the Single-use Plastic Directive was adopted in 2019 as part of the EU Plastics Strategy (Directive (EU) 2019/904).

The Single-Use Plastics Directive in a nutshell

The EU single-use plastics Directive ('*SUP Directive*') aims to reduce the negative impact of plastic products on the environment by reducing and preventing waste generation and by promoting sustainable and non-toxic reusable products and reuse (Directive (EU) 2019/904). The Directive includes several measures related to reduced consumption, market restrictions, product design requirements, marking/labelling requirements, extended producer responsibility, separate collection and awareness raising. It covers certain product categories which are inherently made of plastic (wholly or partially) and are intended to be used one or few times before being discarded. This mostly comprises single-use food, snack and beverage containers and cutlery and packaging materials such as bags and wrappers. The scope of the Directive also includes products that are not considered as packaging, such as cigarette filters, wet wipes, sanitary towels or cotton buds. EU Member States need to integrate the Directive into their national laws by 1st July 2021. While the timeline for the implementation of particular measures and achieving related targets differs, measures related to banning, marking requirements and awareness raising apply from July 2021 already.

It is important to highlight that this report does not aim to assess the effectiveness or ambitions of the Single-use plastics Directive. While some of the products in scope of this study are mentioned in the context of the Single-use Plastic Directive (e.g. food containers), others are not (e.g. medical protective equipment). Similarly, not all single-use plastic products mentioned in the Single-Use Plastic Directive are expected to be directly influenced by the COVID-19 response and, as a consequence, are not discussed in this report.

Impact of Covid-19 on the use of single-use plastics throughout Europe

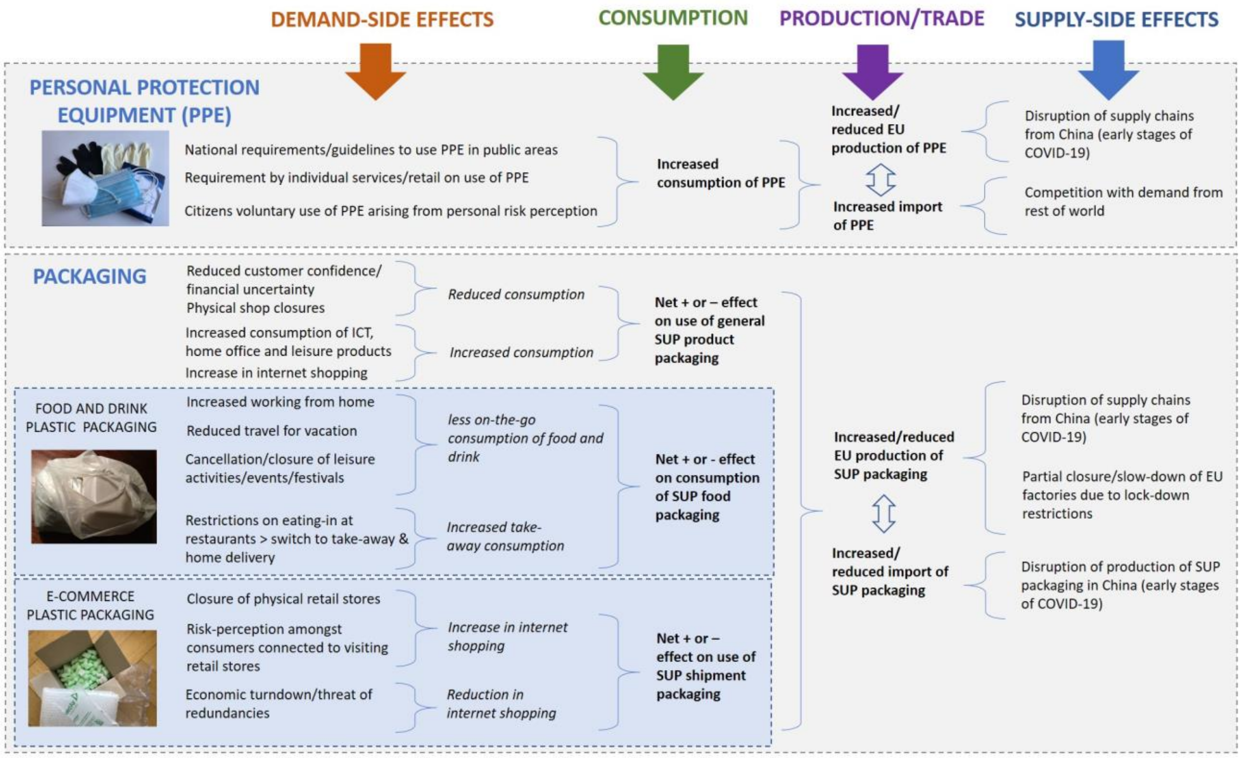
The COVID-19 response, involving lockdowns, social distancing measures and the use of personal protective equipment (PPE), had considerable effects on the use of single-use plastic products. Several single-use medical protection equipment products are considered instrumental to guarantee hygiene standards and prevent virus spreading during the pandemic and are being used extensively, not only by health workers, but by the general public as a precautionary measure. While face masks have been recommended or made obligatory for use by the general public, gloves were not, but are being used extensively anyhow. The use of single-use food packaging is expected to be impacted by the changing lifestyles, altered consumption patterns and behaviour induced by the precautionary measures (e.g. reduced on-the-go drinks, increased take-away food). Additionally, the expected shift to online shopping may have increased the use of e-commerce packaging.

Following a scoping exercise, the following single-use plastic products were selected to be studied more in-depth in relation to the COVID19 pandemic and responses: medical personal protection products directly related to COVID-19 measures (i.e. face masks and gloves) and plastic packaging, with a focus on packaging for food and drink services and packaging for e-commerce.

2.2 Identifying potential effects on consumption, production and trade in single-use plastics

Figure 2-1 presents an overview of potential causal links between the response to COVID-19 and the consumption, production and trade in these types of single-use plastic products and packaging.

Figure 2-1 – Overview of potential links between the response to COVID-19 and the consumption, production and trade in single-use plastics



Source: ETC/WMGE based on compilation PlanMiljø, Oeko-Institut and IDEA Consult

Perhaps the most noticed effect of the COVID-19 pandemic has been the increase in demand for personal protection equipment, such as face masks and gloves, not only in medical facilities, but also increasingly in general society, following national health guidelines. The supply of these products was disrupted, especially in the early stages of the pandemic, due to limited EU production capacities, disruptions in production chains and global competition for imports. These factors altered over the course of the pandemic as producers both in the EU and the rest of the world responded to the increased demand.

For plastic packaging, there are several demand-side effects that pull in different directions. On the one hand, the closure of physical shops and businesses, as well as reduced consumer confidence and financial uncertainty, may have caused an overall reduction in consumption of consumer goods, reducing use of associated packaging. On the other hand, due to the shift to working, studying and staying at home, an increase in consumption of ICT products, home office supplies and products for at-home or outdoor leisure activities could be expected, increasing the use of associated packaging. Also, a shift to online shopping can be expected.

Two packaging types that are particularly expected to be impacted by the COVID-19 response are food and drink packaging and e-commerce packaging; these will be looked into in more detail. On the one hand, social distancing measures led to increased working from home, reduced commuting and travelling and the cancellation of leisure activities and events. This may have resulted in less on-the-go consumption of food and drinks in single-use cups and containers. On the other hand, restrictions on eating-in at restaurants and cafés may have led to increased take-away and home delivery of food, resulting in an increased use of food packaging. Additionally, there are examples of chains of coffee shops and other food and drink services that have placed restrictions on the use of reusable containers due to hygiene concerns (Evans, 2020). The overall net effect may be either an increase or a reduction in net demand for single-use plastic food and drink packaging. Concerning e-commerce, a shift to online shopping as a result of physical shop closures would result in an increased use of plastic packaging by the e-commerce sector. However, it is difficult to estimate what the net effect would be of an increase in online sales compared with a general reduction of consumption due to economic turndown.

Supply side factors can also potentially have had an effect on the European production of plastic packaging. Potential factors include disruptions in supply of raw materials for plastic production from other affected regions, the closure of work places, labour shortages due to illness, quarantine measures and the closure of schools and child care facilities. Finally, oil price reductions early in the pandemic reduced costs of raw materials for the plastics industry.

These factors and their overall effects are investigated in the sections below, for each product group.

2.3 Methodological approach

To estimate the trends in consumption, production and trade of single-use plastic following the outbreak of the pandemic, a literature review of scientific and industry publications was complemented with quantitative and qualitative data obtained from:

- European databases on production and trade of plastic products and packaging
- Interviews with key industry representatives and organisations related to the affected branches
- 2 online workshops with EEA countries through National Reference Centres, National Focal Points, European Topic Centres and the Environmental Protection Agencies Network Interest Groups on Waste, Plastics, Resource Efficiency and Green Economy.

An overview of identified and evaluated data as well as interviewed organisations and interview questions, are provided in Annex 1. The studied time-frame runs from the start of the COVID19 pandemic (January 2020) until September 2020.

Data sources that both cover the EU and other EEA countries, and provide monthly trends covering the period January-September 2020 are relatively sparse. As a result, developing quantitative estimates required the use of assumptions and extrapolations from historical trend data. Moreover, data sources often do not distinguish between 'single-use' and 'multi-use' plastics, neither do they specify the types of plastics used nor for which end uses the products are used. In order to make estimates, approximations and assumptions needed to be made. Similarly, as a multitude of direct and indirect effects can be expected from the COVID19 pandemic and associated responses, it is somewhat speculative to identify clear causes behind observed trends or determine net effects when different factors pull in various directions. These limitations call for some caution in interpreting the results. Assumptions and methods used for each section are provided in footnotes.

2.4 Trends in consumption and production of single-use plastic medical protection equipment

In order to monitor the trade in medical products associated with the COVID-19 pandemic, Eurostat created a new dataset 'EU trade since 2015 of COVID-19 medical supplies"[11], with covers 156 different products groups under seven headlines[3]. However, only a few of these products fall into the category of single-use plastics and specifically used to combat the spread of COVID-19.

Two groups of products in the statistical dataset clearly represent single-use plastic protection equipment that have been widely used by the general public: ‘face masks (excluding paper masks)’ and ‘gloves made from vulcanized rubber or plastic sheeting’. Up-to-date EU production data for these products was not available, but was known to be rather limited (Kretschmer, 2020; OECD, 2020c). As a result, net imports were considered as a proxy indicator to quantify EU consumption.

Another product-group initially considered for inclusion in this study was ‘plastic dispensers for hand sanitizer’. However, due to the lack of EU production data and suitable proxy of EU consumption[4] for the studied period, this product group was not considered further.

Face masks

During the course of the pandemic, governments across Europe have increasingly required or recommended the use of face masks by the general public. These measures were gradually introduced across EU countries as research delivered more evidence for their effectiveness in reducing COVID-19 transmission by capturing droplets released during talking, coughing or sneezing (Lyu and Wehby, 2020; Peeples, 2020), reducing the dose of virus spread, possibly resulting in milder infections (Chu et al., 2020; Gandhi et al., 2020) and by raising risk awareness, encouraging wearers and those around them to adhere better to other measures, such as social distancing (Marchiori, 2020).

Figure 2-2 – Examples of single-use face masks

Source: Photograph by Oeko-Institut

Although the World Health Organization (WHO) did not recommend face masks for general use in public areas (i.e. public transport, shops, etc.) until 5th June 2020 (WHO, 2020b), many governments had already recommended or required the use of face masks prior to WHO’s endorsements. As the pandemic proceeded, these requirements became more widespread across Europe (Gehrke and Furlong, 2020).

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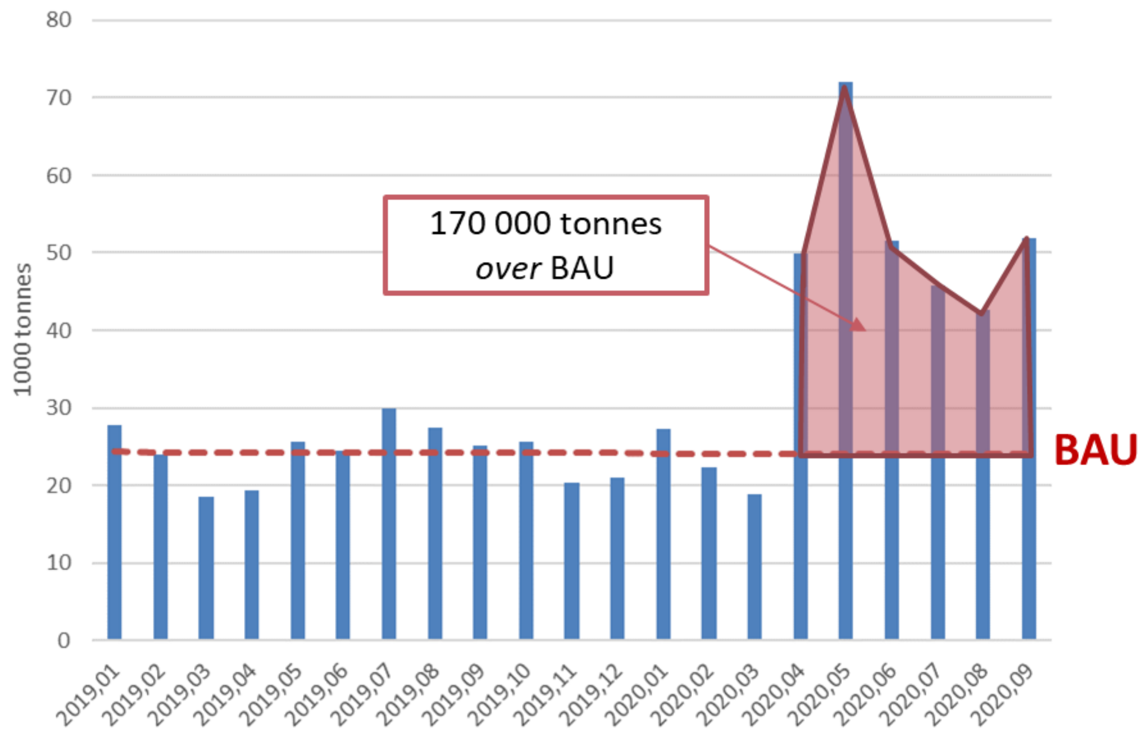
[3] The dataset is based on an indicative product list elaborated by the European Commission in the framework of Commission Decision N° C(2020) 2146 on the basis of a joint WCO/WHO list for COVID-19 medical supplies. The seven headlines are: A) COVID-19 Test kits/ Instruments and apparatus used in diagnostic testing; B) Protective garments and the like; C) Disinfectants and sterilization products; D) Oxygen therapy equipment; E) Medical devices and equipment; F) Medical consumables; G) Medical vehicles and furniture.

[4] since there were no indications that domestic production of this product group was limited (see import /export volume reported by Eurostat in data set Eurostat ‘EU trade since 2015 of COVID-19 medical supplies’: DS-1180622), net imports would not be a good indicator of total consumption.

There is no data available on the usage volumes of single-use face masks and other personal protection equipment in Europe. However, we do have data on the net import of personal protection equipment to Europe, which provides a reasonable proxy indicator of use, at least during the early phase of the pandemic where European production capacity was limited. Prior to the pandemic, France and Germany were the only EU countries with a significant share of global production of face masks (7 % and 2 % respectively of global exports in 2017). The largest producer is China that already dominated trade prior to the pandemic (41 % of global trade in 2017) and further expanded its production 10-fold between January and April 2020 (OECD, 2020c).

In 2019, prior to the pandemic, EU-27 imports of facemasks amounted to 289 000 tonnes. During the 1st European wave of the pandemic, between April-September 2020, the cumulative net imports of face masks to the EU-27, over and above business-as-usual[5] (BAU) net imports, totaled 170 000 tonnes (represented by the shaded area in **Figure *2-3***). Assuming an average face mask weight of 2.7 grams, this corresponds to an average import of 0.75 face masks per person per day for the entire population[6] of the EU during this 6-month period. It should be noted here that the imports don't necessarily reflect actual use. There may have been some stockpiling of face masks during the first six months of the pandemic by retailers, healthcare services and others, that have yet to be used, although no concrete evidence of this has been found to date.

Figure 2-3 – Total net imports of face masks to EU-27 from rest of world – showing the cumulative imports over and above the business-as-usual (BAU) trend



Source: Graph by PlanMiljø, Oeko-Institut and IDEA Consult using data from Eurostat data set DS-1180622 for product code B1 face masks (excluding paper masks)

[5] Business-as-usual (BAU) is calculated as the best fit regression line of monthly import data between January 2019 and February 2020 e.g. the 14-month period immediately preceding the arrival of COVID-19 to Europe

[6] EU27_2020 population (by 2020): 447.8 m people

Plastic gloves

While regular washing and sanitising of hands with soap and disinfectants is general recommendation to reduce COVID19 transmission (WHO, 2020a), the use of gloves by the general public has not been recommended as a preventive measure by international healthcare organisations, such as WHO or the European Centre for Disease Prevention and Control (ECDC, 2020). Some national governments have, nevertheless, recommended the use of gloves by the general public in certain situations. Notably, both the Spanish (El Confidencial, 2020) and Italian (Ministero della Salute, 2021) Ministries of Health recommend the use of gloves when handling bread, fruit and vegetables in supermarkets and other shops as a supplement to other measures. In other countries, there are also cases of shops, supermarkets and other services that provide gloves for use by their customers. A survey in Poland identified that just over half of the population wear gloves when shopping (Statista, 2020).

There is even some evidence that the use of gloves can increase the risk of transmission since the virus can survive on plastic surfaces for up to 72 hours (van Doremalen et al., 2020) and since wearing gloves may lead to a neglection of hand hygiene practices (WHO, 2009; Leazenby, 2020; Otter, 2020). Additionally, concerns have risen that usage of medical grade gloves by the general public can create a shortage of supplies for healthcare workers (Myupchar, 2020).

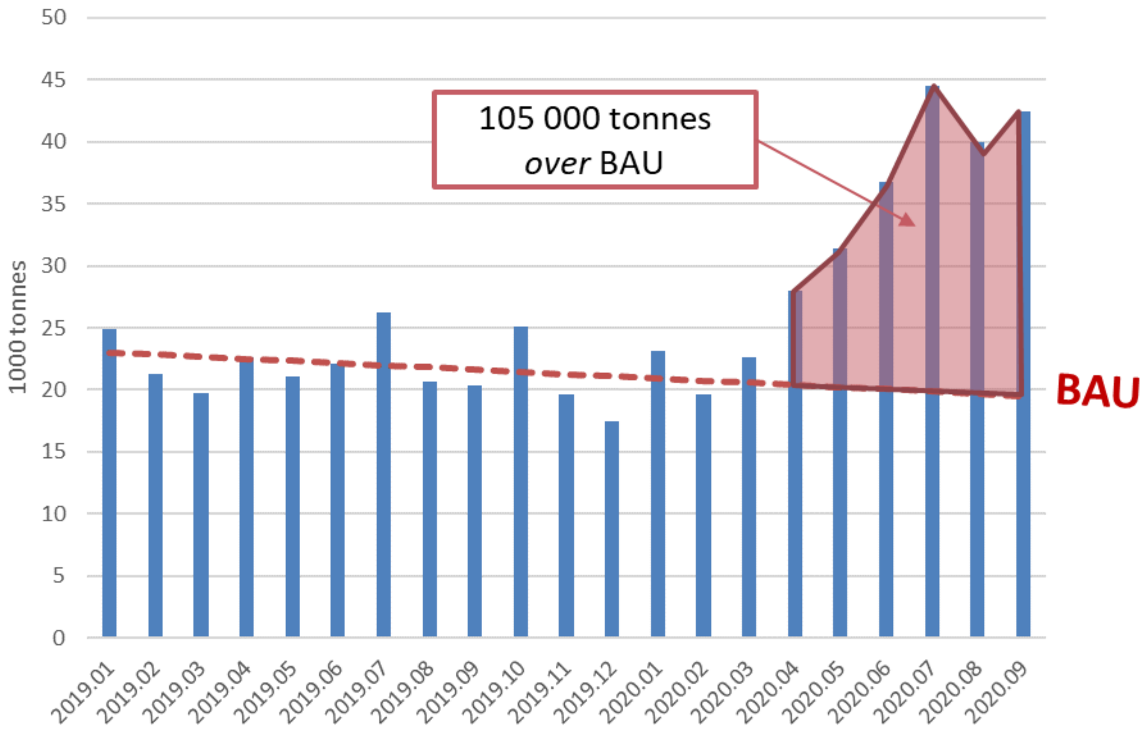
Figure 2-4 – Examples of single-use plastic gloves

Source: Photograph by Oeko-Institut

In 2019, prior to the pandemic, EU-27 imports of plastic (including rubber) gloves amounted to 261 000 tonnes. Between April-September 2020, the cumulative net imports of these gloves to the EU-27 over and above business-as-usual[7] (BAU) net imports (area shaded in red), totaled 105 000 tonnes (Figure 2-5).

[7] Business as Usual is calculated as the best fit regression line of monthly import data between January 2019 and February 2020 e.g. the 14-month period immediately preceding the arrival of COVID-19 to Europe

Figure 2-5 – Net imports of plastic and rubber gloves to EU-27 from rest of world – showing the cumulative imports over and above the business-as-usual (BAU) trend



Source: Graph by PlanMiljø, Oeko-Institut and IDEA Consult using data from Eurostat data set DS-1180622 for product codes: B3-40151900 Gloves, mittens and mitts, of vulcanised rubber (excl. surgical gloves); B4-39262000 Articles of apparel and clothing accessories produced by the stitching or sticking together of plastic sheeting, incl. gloves, mittens and mitts

2.5 Trends in consumption and production of single-use plastic packaging

In this chapter, the impact of the COVID-19 pandemic on the use of single-use plastic packaging in the EU is estimated. After a rough estimation of the overall impact on the use of general packaging, a specific focus is put on plastic packaging used by the food services sector and plastics packaging used for shipping of products purchased online (e-commerce).

Plastic packaging is manufactured from many types of plastics and used to protect or contain a broad range of goods. Not all plastic packaging comprises single-use plastics. Some plastic packaging is reusable and is out of the scope of this study. However, estimating the EU single-use plastic packaging consumption during the period April-September 2020 faces several challenges. While general EU production data for plastic packaging is available on a monthly basis for the period April-September 2020, no trade data for 2020 (import-export) are available yet during the writing of this study. Also, no specific data on the share of single-use plastic packaging – let alone on the use of single-use packaging for specific sectors such as food services or e-commerce - are available. Consequently, resulting estimates should be considered with care.

Figure 2-6 - Single-use plastic packaging (left: take-away food; right: e-commerce)

Sources: Own photographs by Oeko-Institut

General plastic packaging

The European plastics packaging industry produces a wide range of products for use by businesses, government and private households. In 2019, around 18,8 million tonnes of plastic packaging were produced in Europe (Eurostat DS-066341), accounting for almost 40% of the total European plastics production (Plastics Europe, 2020). The European consumption[8] of plastic packaging, taking into account imports and exports, amounted to 18,7 million tonnes in 2019. No data are available on what share of this plastic packaging is to be considered 'single-use'.

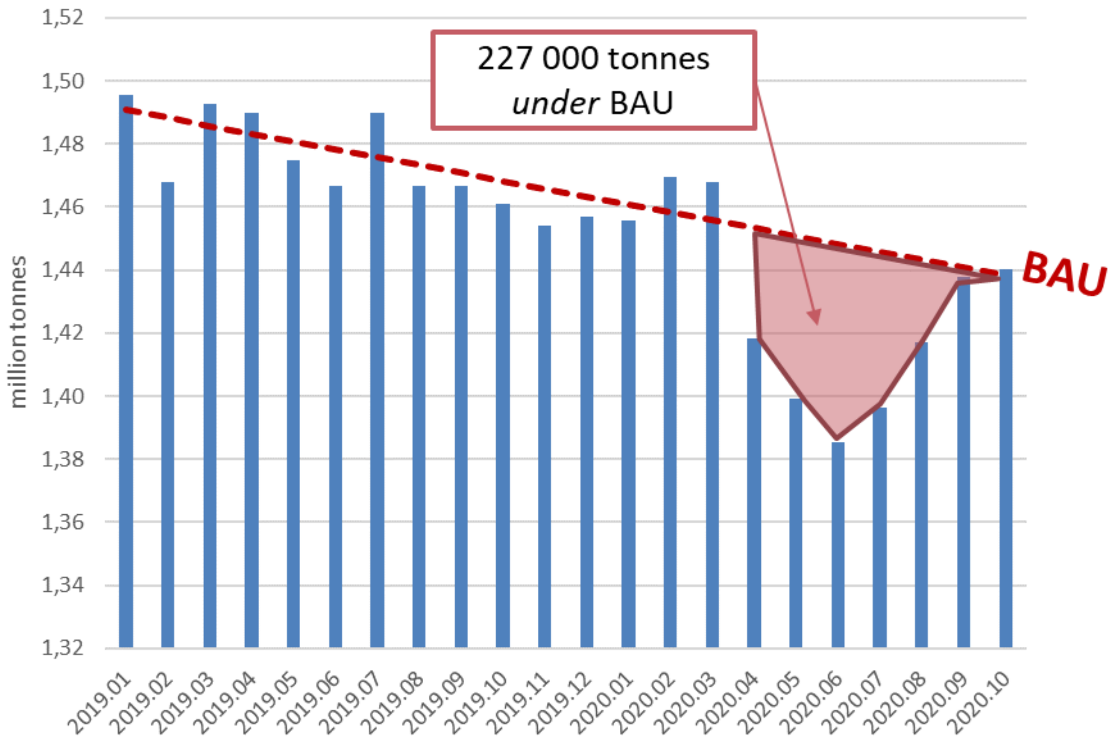
However, production of the EU plastics packaging industry has been decreasing gradually since 2017. In the period between January 2019 and February 2020 (the pre-COVID business-as-usual selected for this project) production decreased on average by 650 tonnes per month. In the months following the arrival of the pandemic in Europe, production decreased much more rapidly (see Figure 2-7). The cumulative reduction in plastic packaging production in EU-27$_{2020}$ beyond the business-as-usual (BAU)[9] downward trend (represented by shaded area in Figure 2-7) amounted to approximately 227 000 tonnes during the period April to October[10]. By October 2020, production had returned to business-as-usual quantities. At the time of this study, it was too early to draw conclusions about the further evolution of EU plastic packaging production during the second wave of the pandemic.

[8] Calculated as 'production + import – export', based on 2019 Eurostat data (DS-066341)

[9] Business-as-usual (BAU) is calculated as the best fit regression line of monthly production data between January 2019 and February 2020, i.e. the 14-month period immediately preceding the arrival of COVID-19 to Europe

[10] The detailed methodology for the calculation is attached in Annex A1.1

Figure 2-7 – Reduction in the production the plastic packaging in the EU-27$_{2020}$ during April to October 2020 compared to business-as-usual trends



Source: own calculations by PlanMiljø, Oeko-Institut and IDEA Consult from Eurostat datasets sts_inpr_m and DS-066341[11]

The reduction in EU production can potentially have had several causes. It could have been caused by a lower demand in Europe (which is the main market for products produced by the EU industry) and globally or it could have resulted from production barriers, such as restrictions in workforce or the shut-down of work places during lockdowns across Europe, supply disruptions of raw materials from China (as a result of the earlier impact of COVID-19 there), or workers' absenteeism due to illness, quarantine measures or the closure of schools and child care facilities. In 2019, 17.6 % of EU plastic packaging production took place in Italy[12] – a country particularly hard hit in the early months of the COVID-19 pandemic.

Following reports by the packaging industry, it is unlikely that supply-side factors were the main cause for the production decline between April and October 2020. In a report published in May 2020, the packaging industry did not report having been affected by supply disruptions in China and elsewhere, neither did it report a shortage of workers due to lockdown measures directly affecting production capacity (EuPC, 2020). There had been, however, some impact from travel restrictions across Europe that had partially affected the maintenance and servicing of machinery for plastic packaging production (ibid). Also, to save labour costs some parts of the industry made use of temporary unemployment schemes where these were available.

Demand-side factors within the EU are, therefore, the most likely cause of the 227 000 tonnes reduction in EU plastic packaging production between April and October 2020. Earliest affected were producers of packaging for industrial applications, but in March the industry also foresaw reductions in demand for packaging from the food services, retail and hospitality sectors due to closures and restrictions (EuPC, 2020). Also, general household consumption expenditure was significantly affected by the COVID-19

[11] The detailed methodology for the calculation is attached in Annex A1.1

[12] own calculations from Eurostat datasets sts_inpr_m and DS-066341, The detailed methodology for the calculation is attached in Annex A1.1

pandemic, particularly in the second quarter of 2020 (Table 2-1). Plastic packaging can be associated with purchases of all types of goods and services, though perhaps mostly weighted towards non-durable goods[13], such as food, cleaning products, toiletries etc.[14].

Table 2-1 – Trends in plastic packaging production and household expenditure in Q2 and Q3 2020

2020	Q2	Q3
EU plastic packaging production (tonnes) compared to BAU	-3.4%	-1.8%
Household consumption expenditure (current prices) on all goods and services compared to same quarter in 2019	-16.0%	-4.9%
Household consumption expenditure (current prices) on semi-durable goods, non-durable goods and services, compared to same quarter in 2019	-15.7%	-5.8%
Household consumption expenditure (current prices) on non-durable goods compared to same quarter in 2019	-4.1%	-0.8%

Data source: own calculations by PlanMiljø from Eurostat datasets: namq_10_fcs; sts_inpr_m and DS-066341

Trends in two different types of plastic packaging connected with the purchase of services are discussed below.

Single-use plastic packaging for delivery and take-away food services

The restaurant and food services sector was hard hit by the first wave of the COVID-19 pandemic in Europe. In April 2020, the turnover of the sector that otherwise had seen a 25 % growth since 2015, was 68 % less than the turnover achieved in April 2015 across the EU-27. Overall, turnover was reduced by 45 % compared to business-as-usual for the months of March to August 2020.
The sector was particularly hard hit in Spain and France. Turnover rebounded towards August as lockdowns were relaxed[15], but again showed signs of a further turndown by September 2020 (Figure 2-8).

It is likely that the sector has been further hit by increasing restrictions during the second wave of the pandemic. In many countries bars and restaurants were closed again in the course of autumn 2020, for example, in Belgium from 19th October onwards, in some regions of Spain from late September and in Germany from 2nd November 2020 (OECD, 2020b).

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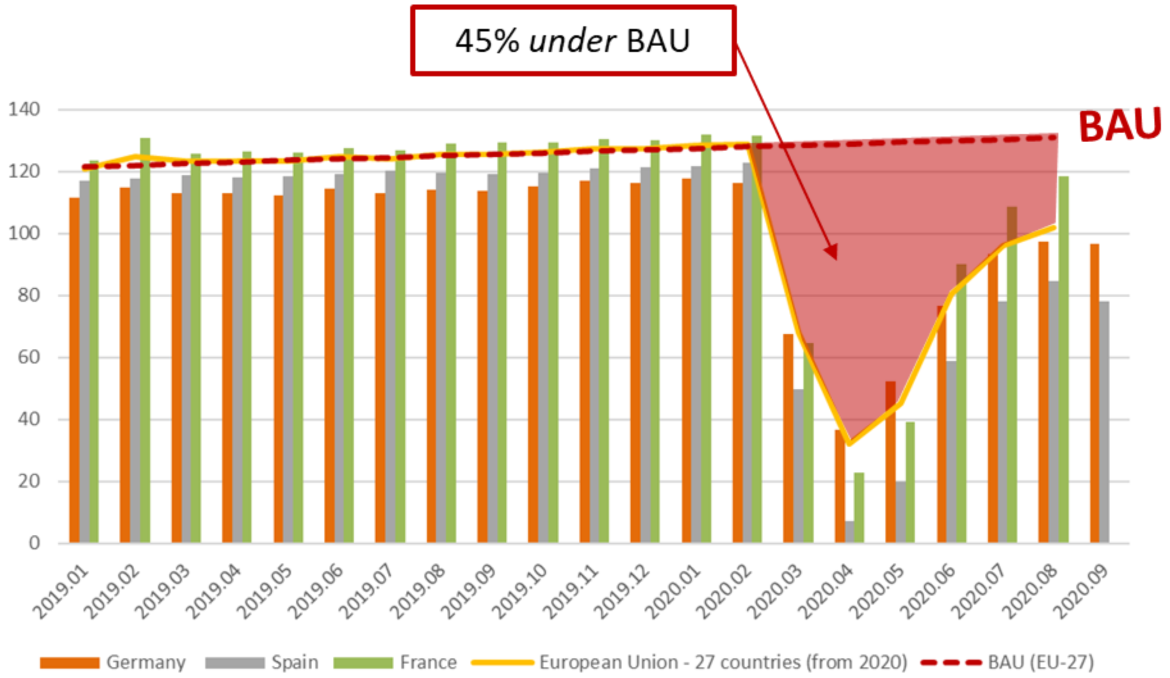
[13] See exact NACE categories considered for the aggregate 'Consumer non-durables' in Commission Implementing Regulation (EU) 2020/1197 (30 July 2020) Annex II. OJL 271 (18 Aug 2020), p.1 – p. P170.
[14] The assumption that packaging is essentially linked to non-durable goods is also reflected in the Packaging Directive (Directive 94/62/EC last amended by Directive (EU) 2018/852), which assumes that packaging is waste in the same year in which it is placed on the market.
[15] France temporarily re-opened restaurants and bars on 15th June 2020, and Spain from the end of May 2020, though with restricted capacities (OECD, o. J.)

Figure 2-8 – Trends in turnover of food and beverages services sector, January 2019 to September 2020 indexed to 2015 (seasonally and calendar adjusted)



Source: Graph by PlanMiljø, Oeko-Institut and IDEA Consult derived from Eurostat ProdCom monthly dataset [sts_setu_m] for NACE code I56

However, the reduction in turnover did not necessarily result in a reduction in single-use packaging used by the sector. Many companies in the sector adapted their activities and business models in response to restrictions during the first wave of COVID-19. As restaurants were closed in many countries for sit-in meals during the first months of the pandemic, and again during the second wave, many shifted their activities towards take-away meals or home deliveries (although, for example, home deliveries were banned in the hardest hit regions of Italy (Furlong, 2020)), which may have resulted in an increased use of packaging.
As is apparent from Figure 2-8, the shift in the business model was not sufficient to fully protect the turnover of the industry. However, those countries that saw the least damage to the food services sector were those with the highest penetration of meal delivery services (Kantar, forthcoming). Online ordering player Deliveroo reported that Friday and Saturday home delivery orders in May 2020 were on average 36 % higher in Europe than pre-lockdown numbers in February 2020. Moreover, while working from home may have negatively affected restaurant traffic, it also created new opportunities. During April, May and June 2020, delivery firms reported a 50 % increase in breakfast orders and an 80 % increase in lunch orders compared to February of the same year (Khan et al., 2020). Moreover, a global-wide consumer survey found that approximately 35 to 55 % of consumers in the five largest European countries intend to continue using home delivery more in the future (Charm et al., 2020).

On the other hand, the consumption of food and beverages on-the-go is likely to have decreased due to increased working at home and home schooling. For example, commuting fell by 40 % in Germany in the weeks immediately following lockdown and did not return to normal levels until the beginning of July 2020 (destatis, 2021). One market analysis predicted a reduction in sales of coffee from cafés and restaurants by 48 % in Europe during 2020 compared to 2019 (Peluso, 2020). It is not clear which share comprises sit-in coffee and which coffee-to-go, but a similar reduction in single-use coffee cups and lids might be expected. Similarly, on-the-go snacks, including packaging and utensils, are also likely to have decreased.

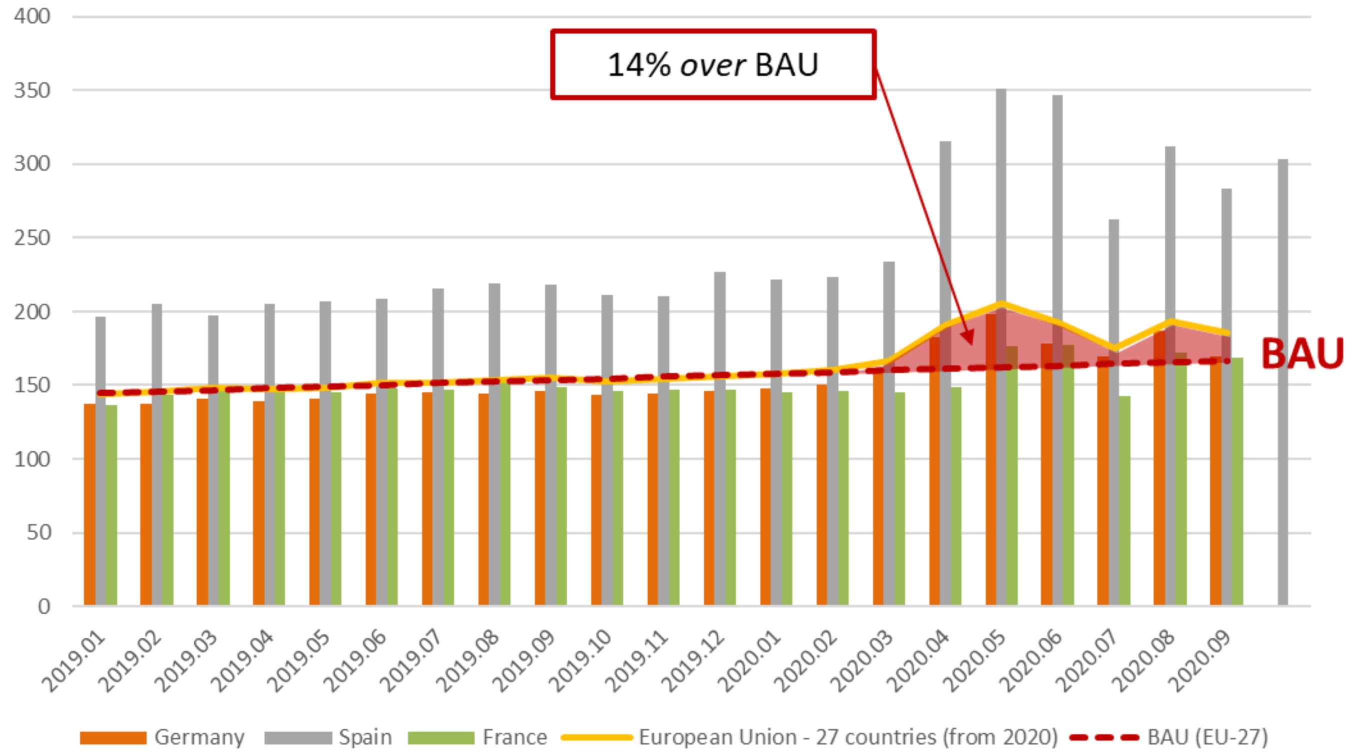
At the time of this report, no reliable data existed to quantify the net effects of increased home deliveries and reduced food and drink on-the-go on overall single-use plastic packaging by the food services industry, neither from the industry itself nor from other sources.

Single-use plastic packaging for online sales and e-commerce

Physical shops, apart from essential services such as food retailers, were closed during the strictest periods of lockdown in many countries in Europe during the first and second waves of the pandemic (OECD, 2020b). These forced closures combined with social distancing measures, placed a large share of traditional retail virtually on hold during the first wave of COVID-19 in Europe (OECD, 2020a), likely to have been repeated during the second wave. Consumers switched their retail activities to online e-commerce sales, although it is important to note that this switch only partially offset losses in sales in physical shops (BBC News, 2020).

The result was an increase in the turnover of the e-commerce sector over and above the business-as-usual (BAU) growth rate of around 1 % on average per month since 2015. The increase in turnover peaked in May 2020 at 25 % over business-as-usual but had returned to near normal levels (5 % over business-as-usual) again by July. In the period between March and September 2020, the e-commerce sector in Europe experienced a cumulative increase in revenue of 14 % above business-as-usual (Figure 2-9).

Figure 2-9 – Trends in turnover of retail via mail order houses and internet[16] January 2019 to September 2020, indexed linked to 2015 (seasonally and calendar adjusted)



Source: Own graph by PlanMiljø, Oeko-Institut and IDEA Consult derived from Eurostat ProdCom monthly dataset [sts_trtu_m] for NACE code G4791

Note: BAU = business-as-usual

Similar increases in e-commerce are likely to have been repeated during the second wave of COVID-19 as many countries again began to restrict or completely close down non-essential physical shops from November 2020, lasting well into 2021 (BBC News, 2021) (OECD, o.J). Also, parcel delivery services have been used at a record level in 2020, with the German postal service (Deutsche Post DHL), for example, expecting an increase of almost 15 % compared to the previous year, corresponding to a total of around 1.8 billion parcels. Especially in the weeks before Christmas, when social distancing measures restricted

[16] NACE code G4791

traditional family Christmas celebrations, record volumes of over 11 million parcels were reported on peak days, compared to an average of 5.2 million parcels on normal days (DHL, 2020).

The increase in e-commerce is likely to have led to a corresponding increase in the volume of plastics used for e-commerce packaging. The Italian National Consortium for the Collection and Recycling of Plastic Packages indicated that the increase in online shopping and its related packaging led to an 8 % increase in total plastic waste in municipal waste in March and April 2020 despite an overall 10 % decrease in municipal waste volumes (Stimulus Check Up, 2020).

To convert the increase in turnover of the e-commerce industry to an increase in plastic packaging used in e-commerce parcels, requires historical data on the volume of plastic purchases by the sector. According to Swedish Environmental Protection Agency (2019), plastic packaging waste from internet shopping by households are rarely reported in statistics (Ljungkvist Nordin and Westöö, 2019). However, privately generated data on the volumes of plastic packaging use in 2019 in some countries including Germany and Spain has been published (OCEANA, 2020). Data on the turnover of the e-commerce sector in France, Germany, Italy and Spain was also available from UNCTAD (UNCTAD, 2020). These two datasets were combined[17] to derive a total use of plastic packaging by the e-commerce sector in EU-27 in 2019. The result was a range of between 125 000 and 193 000 tonnes or approximately 1% of total plastic packaging consumption in EU-27[18].

Comparing the *additional* COVID-19 related economic turnover of the e-commerce industry (Figure 2-9) to its *total* turnover in 2019, led to a 9.1% increase, equaling an estimated 11 400 to 17 600 tonnes additional plastic packaging used by the sector as response to COVID-19 in the period March to September 2020[19].

[17] Two methods were used to calculate EU-27 plastics use by e-commerce. **Method 1** – the average use of plastic packaging per unit GDP was calculated for Germany and Spain. This was then scaled up using the GDP of EU-27 in 2019 to give a total use of plastic packaging by the sector. **Method 2** - global plastic use in the e-commerce industry was divided by global turnover as given by UNCTAD data to give a global plastic use per GDP. This was then multiplied by turnover in France, Germany, Italy and Spain to give total plastic use by e-commerce in these countries. The figure was divided by the share these countries have in EU-27's combined GDP to give a total plastic use in EU-27.

[18] Plastic packaging waste generated in EU-27 lay at 14.8 million tonnes in 2018 https://ec.europa.eu/eurostat/statistics-explained/index.php/Packaging_waste_statistics

[19] The additional turnover above BAU in months March to September 2020, amounted to 9.1% of the total turnover of the sector in the whole of 2019. Thus, the additional plastic packaging use in these months is estimated at 9.1% of total plastic packaging use by the sector in 2019. This method assumes 1) that the increases in e-commerce activity were evenly spread across the products shipped in 2019 and 2) that the sector did not significantly change the *types* of packaging it used between 2019 and 2020.

3 Environmental and climate impacts of single-use plastics related to COVID-19

This chapter analyses the environmental and climate impacts of the changed use dynamics of the single-use plastics during the first wave of COVID19. The overall reduction in plastic packaging production in the first months after outbreak of the COVID-19 pandemic, strongly increased imports of single-use face masks and gloves, together with changing consumer habits in terms of home deliveries and on-the-go food and drinks due to closed restaurants and restricted commuting and long-distance travels, as well as a further increase of e-commerce during lockdowns of local retailers – all of this contributes to changing environmental and climate impacts and must be addressed to keep shaping the path towards a circular plastics economy.

While it is important to recognise that COVID-19-related changes in consumption patterns, trade and production may have effects on a broad range of single-use plastics, this study will focus on medical protection equipment (facemasks and gloves) and packaging (of food delivery services and e-commerce), since these types were evaluated to be most directly impacted, and for reasons of data availability (see also 2.2).

3.1 Methodological approach

For the environmental assessment, the entire life cycle of the single-use plastics in focus of this study is analysed: from the extraction of primary resources and energy sources, the production of the single-use plastic products to the waste management and disposal of materials at the end of their life cycle. Impacts of the use phase are not included in the assessment as the use phase of the products under consideration is typically very short and would normally not require significant resource or energy inputs. Moreover, use impacts strongly depend on individual consumer behaviour, for which no data were available.

Existing life-cycle assessment (LCA) studies and LCA databases were used as a source for calculating the environmental impacts associated with the trends identified in chapters 2.4 and 2.5. A review of recent scientific literature (publication in 2020 or preprints) was complemented by recent public reports, social media posts, expert judgement and interviews with key industry representatives and other organisations related to the affected industries. Additionally, national experiences were reported in two online workshops with EEA countries (see 2.3). If available, datasets from the database Ecoinvent 3.6 were preferred. The evaluation focuses on global warming potential (GWP) as this is a very important impact category for plastics. Other impact categories, such as acidification potential, ozone layer depletion, human toxicity potential or eutrophication, show the same general trend as the global warming potential, and thus are not discussed in detail in the text. A summary table of all impacts can be found in Annex 2. Some impacts have global effects, e.g. greenhouse gas emissions, while others have regional effects, e.g. acidification or eutrophication. Emissions associated with production arise in the countries of origin (e.g. China or Europe), while impacts from waste treatment occur in Europe.

3.2 Impacts of single-use plastic medical protection equipment

It is evident that the increased production and use of single-use face masks and gloves (see 2.4) comes with associated environmental impacts. These impacts are mainly related to their resource extraction, production, transport and waste disposal.

Face masks

Many types of disposable face masks are available on the market. Their material composition depends on the intended use and the manufacturer. For example, medical face masks that meet the requirements of European Standard EN 14683:2014 typically consist of a three-layered structure, consisting of two layers of synthetic (i.e. plastic) textile fabric with a middle layer of dense nonwoven textile filter (see e.g. the surgical mask in Figure 3-1). Respiratory Filtering Face Piece (FFP) masks consist of multiple laminated layers of dense non-woven polyester fleece (see e.g. the FFP2 mask in Figure 3-1).

Figure 3-1 – Types of single-use face masks (left: surgical mask; right: FFP2 mask)

Sources: Own photographs by Oeko-Institut

The wide variety of designs and material combinations of face masks available on the market makes it difficult to aggregate all information and derive an average material composition of face masks, suitable for the environmental assessment. The environmental assessment in this study is based on the material composition of a simplified type of a generic single-use face mask according to Allison et al. (2020). This example face mask is a typical medical face mask that meets the requirements of European Standard EN 14683:2014. In addition to the impact related to the material composition (Table 3-1), Allison et al. (2020) estimate the electricity consumption for manufacturing as 0.792 kWh per 1000 masks.

Table 3-1 – Exemplary material composition and global warming potential (GWP) of a single-use surgical face mask

Component	Material	Area (m2)	Length (m)	Mass (g)	GWP[20] [kg CO2eq/kg material]
Layer 1 – outer	Polypropylene, non-woven (PP)	0.029	-	0.638	2.8
Layer 2 – textile filter	Cellulosic fabric	0.029	-	0.725	0.5
Layer 3 – inner	Polypropylene, non-woven (PP)	0.029	-	0.638	2.8
Nose Wire	High Density Polyethylene (HDPE)	-	0.098	0.231	2.9
Ear Loops	Polyetherimide (elastic material)	-	0.185	0.444	119.6
Total				2.676	

Source: mask composition from Allison et al., 2020; GWP data from ecoinvent 3.6 database for PP, cellulosic fabric and HDPE; GaBi 10 database for polyetherimide

The resulting global warming potential for the manufacturing of this example of single-use face masks is about 21.9 tonnes CO_2eq per tonne face masks[21]. As the production of these masks mainly takes place in China, these emissions occur outside Europe. The largest contribution to the global warming potential (GWP) of the production of this type of single-use face mask, in casu 90%, is caused by the polyetherimide used for the ear loops. However, there is a broad variety of masks on the market, and ear loops can be made from several materials, depending on the manufacturer. If the polyetherimide ear loops are replaced

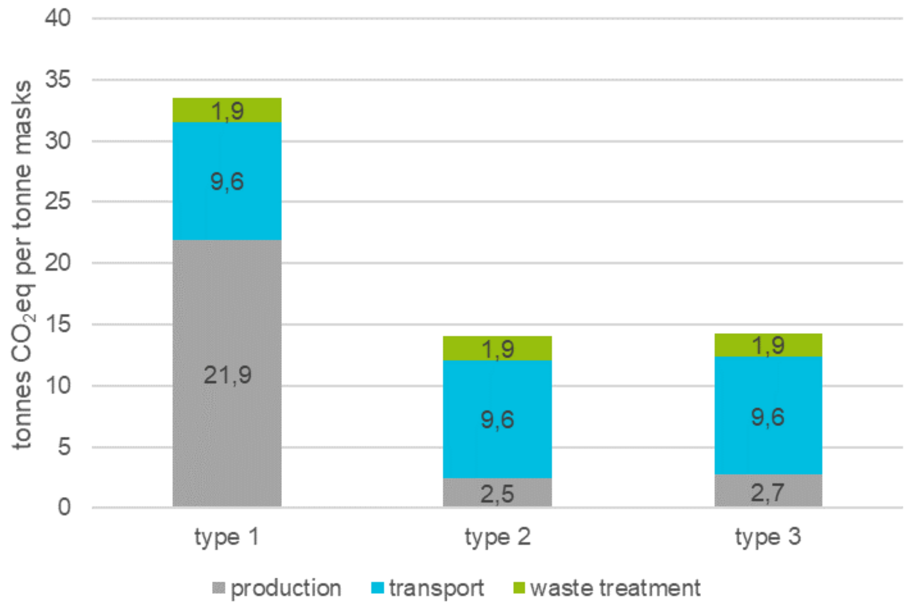
[20] Data from the LCA database ecoinvent 3.6 and from GaBi 10 was used for the manufacturing of materials and electricity input. As most face masks are manufactured in China the Chinese electricity mix was used for the calculation (GWP: 0.92 kg CO_2-eq/kWh)

[21] This corresponds to 59 g CO_2eq per face mask. Calculation by Oeko-Institut, based on mask composition and electricity consumption of manufacturing by Allison et al. (2020); GWP data from ecoinvent 3.6 database for PP, cellulosic fabric and HDPE; GaBi 10 database for polyetherimide

by elastic straps of synthetic rubber (Rizan et al., 2021) or polyester (Paceline, 2021), the global warming potential for the manufacturing of face masks would be, respectively, only 11 % or 12.6% of the emissions compared to masks with ear loops made of polyetherimide[22].

If transport (from China to Europe by airplane) and waste management (waste incineration in Europe assumed) are taken into account, the global warming potential of face masks ranges from 14 to 33.5 tonnes of CO_2eq per tonne masks[23], depending on the ear loop material used (Figure 3-2). Next to material composition, transport is the most important factor determining the global warming potential. In the case of the rubber or polyester ear loops, transport by air from China to Europe contributes for almost 70% to the total impact. While air transport was definitely widely used in the early months of the pandemic when face mask shortages challenged supply and logistics, it can be expected that this was only a temporary situation and that transport by ship will become more prevalent under normalised market conditions later in 2020, reducing the future transport impacts. Also, note that not all municipal solid waste is incinerated in Europe, in some regions landfilling is still common practice. Also, littering is a significant risk in the case of single-use face masks. While landfilling of waste has a negligible impact on global warming potential, the effects of littering are generally not addressed in LCA studies (see section on waste disposal).

Figure 3-2 –Global warming potential (GWP) of single-use face masks with different ear loop materials (type 1: polyetherimide, type 2: synthetic rubber, type 3: polyester). Values assume production in China, transport to EU-27 (by air) and waste management in EU-27 (incineration), per tonne masks



Source: Graph by Oeko-Institut, PlanMiljø and IDEA Consult based on mask composition as described in Allison et al. (2020) and ecoinvent 3.6 database

To estimate the effect of the COVID-19 pandemic on the environmental impacts of the consumption of single-use plastic face masks in Europe, the mass flows estimated in section 2.4 are multiplied with the impacts per tonne masks as calculated above. Figure 3-3 shows the global warming potential of the manufacturing, transport and waste management of single-use face masks imported to EU-27_{2020} between January 2019 and September 2020[24]. Depending on the assumed mask composition, the Business-as-usual (BAU) global warming potential of the EU consumption of face masks, prior to the

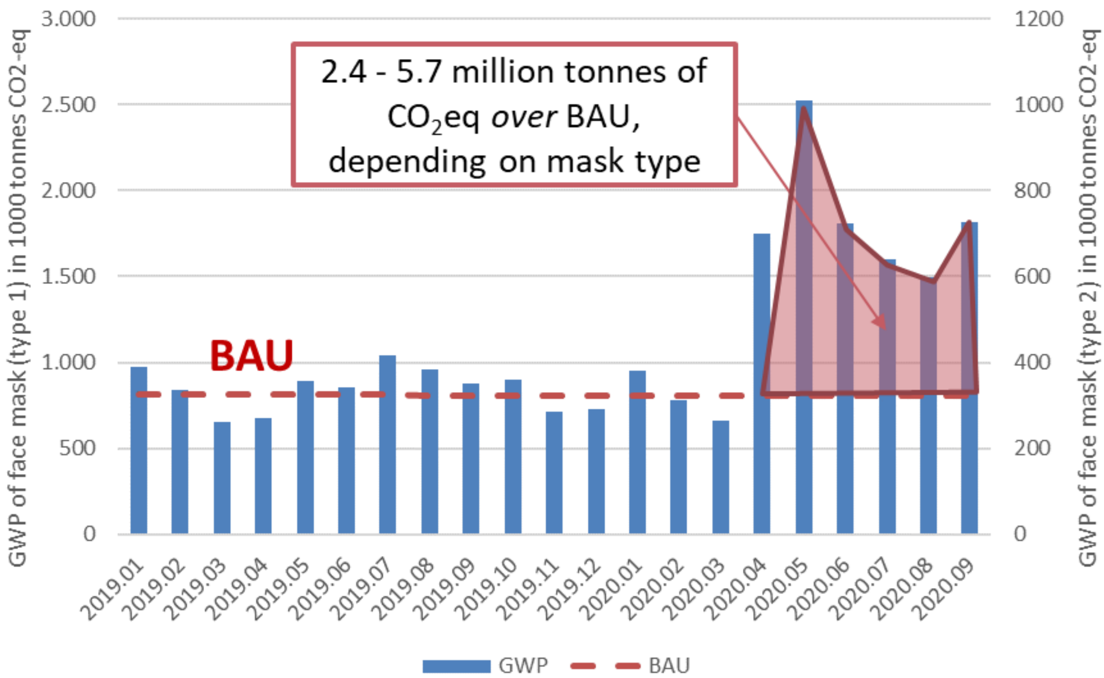
[22] Calculation by Oeko-Institut, based on mask composition by Allison et al. (2020), replacing ear loop composition by synthetic rubber and polyester from ecoinvent 3.6 database

[23] This corresponds to a GWP of 38-90 g CO_2eq per face mask, which is equal to the emissions of a 127-300 m drive in a medium-sized petrol vehicle.

[24] used as a proxy for EU consumption. Only the mask types with the highest and lowest GWP are shown in the graph.

arrival of the pandemic, amounted to 340 - 800 000 tonnes of CO_2 eq per month. Due to the increased consumption of face masks, an additional 2.4 to 5.7 million tonnes of CO_2 eq, above business-as-usual, has been emitted in April-September 2020 (an increase of +118%, or more than double of BAU emissions), mainly caused by mask manufacturing and transport. This corresponds to the annual direct CO_2 emissions of between 1.5 and 3.6 million EU citizens (due to burning of fossil fuels for home heating and transport)[25]. Other environmental impact indicators show the same overall trend (see Annex 2). It is important to note that the emissions were calculated based on one example type of single-use face mask (Allison et al., 2020), only varying the ear loop composition; for other mask types or materials, results may differ.

Figure 3-3 – Estimation of global warming potential (GWP) of the manufacturing of single-use face masks imported to EU-27$_{2020}$ from China between January 2019 and September 2020



Source: Graph by Oeko-Institut, PlanMiljø and IDEA Consult based on mask composition as described in Allison et al. (2020) and ecoinvent 3.6 database

Box 1 Comparison of single-use and reusable textile masks

To overcome the initial shortages of single-use face masks during the first months of the pandemic, and to meet demand for more fashionable and reusable masks, there was also high demand for reusable textile face masks to be used by the general public to reduce virus spreading in public places ('community masks'). WHO guidelines recommend reusable face masks to be made from multiple layers, involving a combination of cotton and polyester fabrics for maximum efficacy. Nevertheless, it is important to note that not all reusable masks on the market comply with these guidelines. Importantly, as their efficacity in preventing virus spread is disputed, their recommended use was limited to the general public. By encouraging the general public to use reusable masks, surgical and medical masks could be reserved for use by health workers, especially in the early days of the pandemic when supply disruptions were afflicting hospitals. As soon as the supply of single-use masks recovered, reusable masks were less recommended by authorities due to concerns about the efficacy and hygiene considerations. Nevertheless, reusable masks are still widely used by the general public

[25] Based on carbon footprints by Eurostat (2021), which calculated that each EU citizen emitted 1.6 tonnes of CO2eq/person direct emissions in 2019, due to burning of fossil fuels (e.g. for home heating and transport fuel)

and generally regarded as more sustainable because they can be reused multiple times, reducing waste generation.

A few first simplified lifecycle assessment studies were performed by Allison et al. (2020) and Schmutz et al. (2020), comparing the environmental impacts of single-use and reusable masks. It is important to note that these studies did not look into the functionality or efficacity of these reusable masks to prevent virus spreading, nor into their compliance with WHO guidelines. Schmutz et al. (2020) compared a single-use surgical face mask (made of PP) and a 2-layed cotton face mask in a number of behaviour scenarios. The study showed that the environmental impact of both surgical masks and cotton masks is dominated by their material composition and production process, whereas waste incineration[26] has only a minor contribution to the overall impact. In comparison to the dominating impacts related to material composition and material weight, machine washing only has a minor impact on the environmental performance of the cotton mask, since these tiny items can easily be washed together with normal laundry. Not surprisingly, increasing the number of reuse cycles (and corresponding washing) of the cotton mask improves its environmental performance in comparison with the use of single-use masks. However, if reusable masks are hand-washed, the impact of washing becomes significant and may flip the overall environmental impact in favour of single use masks (Allison et al., 2020).

Based on the data presented in the study by Schmutz et al. (2020), Figure 3-4 compares the cumulative global warming potential of a reusable cotton mask (including production, washing at 60°C in between each use, and waste incineration) with the equivalent use of a single-use surgical mask, replacing it by a new one after each use (including production and waste incineration) over a period of 30 uses. The tipping point is situated around 13 uses, implying that a cotton mask should have a minimum lifespan of 13 uses (i.e. 12 washing cycles) in order to have a lower environmental impact compared to the use of an equal amount of single-use masks (i.e. 13 pieces). After 30 uses, almost 90% of the overall impact of the cotton mask can still be attributed to the mask's production, 10% to the washing and 0.2% to the waste incineration. For the single-use masks, 63% of the impact is linked to their production and 37% to their waste incineration. Transport of the masks was not included in the simulation.

Note that the numerical results of the comparison are highly dependent on modeling choices, such as mask compositions and process assumptions, which may not be fully representative of the average mask types or material compositions on the market. Also note that transport of the masks from their region of production to Europe was not included in the calculation by Schmutz et al. (2020) [27] and that the use scenarios used for the comparison (i.e. washing of the reusable mask at 60°C after each use cycle, replacement of the single-use mask after each use cycle) may not be in line with actual use behaviour of citizens (e.g. washing may be done less regularly or at lower temperatures than recommended, single-use masks may be reused several times before discarding). The main message of this comparison is that the environmental impact of reusable masks can be decreased by increasing their lifespan and by the use of low-impact materials such as recycled fibres (cotton or synthetic), while machine washing only represents a minor share in the total impact of a reusable mask (if done at full load together with normal laundry). In any case, more in-depth research is needed to get a better understanding how to optimize mask design and use behaviour in order to maximize the

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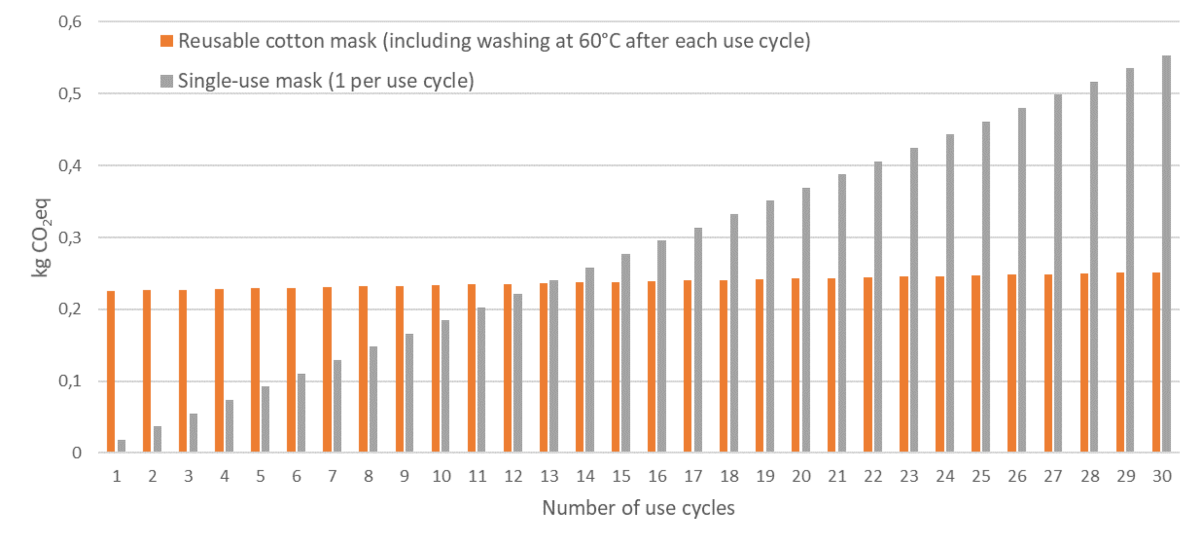
[26] CO_2 emissions from cotton incineration are considered biogenic and are not taken into account in the carbon footprint of the cotton mask. Incineration of a surgical mask has fossil CO_2 emissions and accounts for 36% of the total carbon footprint of the surgical mask.

[27] Note that the GWP per single-use face mask is 0.02 kg CO_2eq per mask according to Schmutz et al. (2020) excluding transport, while the GWP calculated in this study varied between 0.04 and 0.09 kg CO_2eq per face mask based on the composition by Allison et al. (2020), including transport. As was shown, transport impacts make up a considerable share of the total impact.

sustainability of reusable masks, in a such way that not compromises hygiene and effectiveness in terms of protection of the general public.

Figure 3-4 – Comparison of the global warming potential (GWP) associated with the use of a reusable cotton mask (including washing) and single-use surgical masks



Source: Calculations and graph by VITO based on Schmutz et al., 2020

Plastic gloves

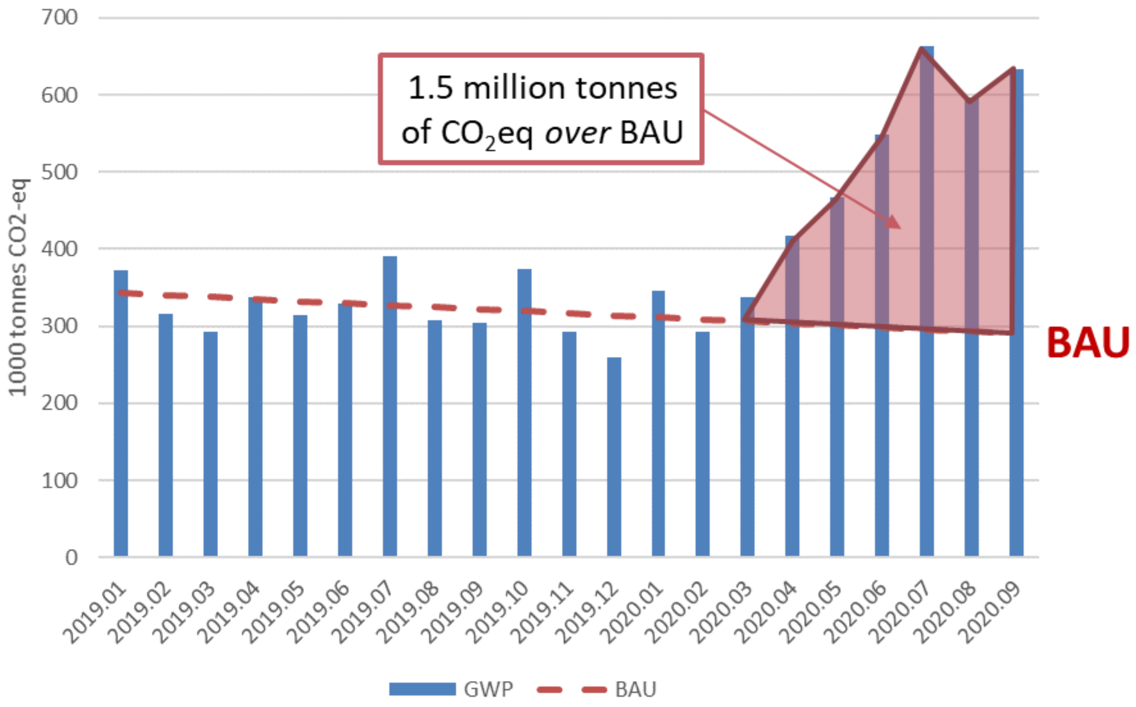
As no information is available on the actual market share of the two materials used for single-use gloves (synthetic rubber and high-density polyethylene), a simplified approach was taken, assuming 50 % made of synthetic rubber and 50 % of high-density polyethylene.

The manufacturing of 1 kg of gloves causes 2.44 kg of CO_2eq, the transport 9.6 kg of CO_2eq (from China to EU-27_{2020} by airplane), and waste management (incineration) 2.9 kg of CO_2eq, i.e. in total 14.9 kg of CO_2eq per kg gloves[28]. Two thirds of this impact is related to transport (by airplane). Note that under normalised market conditions, transport by ship will become more prevalent, reducing the future transport impacts. Also, note that not all municipal solid waste is incinerated in Europe, in some regions landfilling is still common practice. While landfilling of waste has a negligible impact on global warming potential, it may contribute to littering, especially when open landfills are concerned (see section on waste disposal).

Figure 3-5 shows the global warming potential for production of gloves between January 2019 and September 2020, based on available Ecoinvent data for synthetic rubber gloves and polyethylene gloves (50/50).

[28] This corresponds to the CO_2 emissions of a 44 km drive in a medium-sized petrol vehicle.

Figure 3-5 – Estimated Global warming potential (GWP) of the manufacturing of single-use gloves imported to EU-27₂₀₂₀ between January 2019 and September 2020



Source: own graph by Oeko-Institut, PlanMiljø and IDEA Consult based on ecoinvent database version 3.6

The pre-COVID-19 scenario (business-as-usual) is calculated as the best fit regression line of monthly greenhouse gas emissions from gloves (manufacturing, transport and waste management after usage) imported[29] to EU-27_{2020} between January 2019 and February 2020, i.e. the 14-month period immediately preceding the arrival of COVID-19 to Europe. Business-as-usual (BAU) global warming potential of the EU consumption of single-use gloves, prior to the arrival of the pandemic, amounted to around 325 000 tonnes of CO_2 eq per month (i.e. 3.9 million tonnes per year). The COVID-19 scenario is calculated from the average value of the greenhouse gas emissions from the manufacturing, transport and waste management of gloves imported to EU-27_{2020} between April and September 2020. The net emissions are calculated from the difference between the two scenarios, resulting in an additional 1.5 million tonnes of CO_2 eq, above business-as-usual, that has been emitted in April-September 2020 (+77%). This corresponds to the annual direct CO_2 emissions of almost 940.000 EU citizens (due to burning of fossil fuels for home heating and transport)[30]. Other environmental impact indicators show the same trend over the years 2019 and 2020 (see Annex 2).

Waste disposal and management of personal protective equipment

While the impacts related to waste disposal of face masks and gloves were included in the environmental analysis in the previous paragraphs, some additional observations are highlighted in this section.

Global volumes of disposable surgical face masks were already in the millions before the outbreak of the COVID-19 pandemic. Traditionally, they were part of the hospital waste which is incinerated in the EU. Since the global outbreak of COVID-19 pandemic, however, disposable face masks have proliferated the everyday life of the world's population as their use in public places has become mandatory in most countries of the EU. Across Europe, countries experienced different effects on their waste management capacities (Tsukiji et al., 2020). Generally, citizens were instructed by governments to dispose of single-use

[29] used as a proxy for EU consumption

[30] Based on carbon footprints by Eurostat (2021), which calculated that each EU citizen emitted 1.6 tonnes of CO2eq/person direct emissions in 2019, due to burning of fossil fuels (e.g. for home heating and transport fuel)

face masks in the mixed municipal solid waste. Some municipalities recommended that potentially contaminated personal protection equipment used by citizens should be additionally put into sealed and leak-proof garbage bags when disposed of in the mixed waste. Following these recommendations, it can be assumed that most disposable masks and gloves end up in the municipal solid waste, which is typically incinerated, although landfilling is still common practice in some regions in Europe (Box 2).

Box 2. Waste generation of personal protective equipment in Italy

The Italian institute ISPRA has estimated that there will be between 160 000 and 440 000 tonnes of additional waste from medical protective equipment to be disposed of by 2020 in Italy (Giliberto, 2020). Municipal solid waste (MSW) and medical waste is usually treated in incineration facilities according to EU law, but the practice of landfilling cannot be ruled out. A large part of the personal protection equipment used by the general public will likely end up discarded without precautionary measures in regular MSW, or worse, littered in the environment (Patrício Silva et al., 2020). If only 1 % of the masks used in a month would end up in the environment, deliberately or accidentally, this would result in 10 million of masks per month littered in Italy alone (Giliberto, 2020). Especially in regions where incineration plants are rare, ecology experts warn that a large amount of used sanitary masks might end up in landfills or dispersed into the environment.

Ragazzi et al. (2020) estimated that the annual amount of waste disposable face masks and gloves in Italy could amount up to 175 000 tonnes, representing 1.39 % of the national residual municipal solid waste (RMSW) production in 2018. Such data demonstrate that, although the number of masks and gloves that would be disposed of as RMSW is huge, it could be of minor concern in the management of MSW at a national level.

Many people tend to dispose of used personal protection items in the environment or lose them unintentionally. Many places lack adequate disposal infrastructure to collect the potentially infectious personal protection waste items, making them prone to littering. For instance, a French survey conducted in July 2020 revealed that 5 % of French people admit to throwing away their masks on public roads, which would be over 2 million people (Connexion, 2020). Furthermore, in Italy, many supermarkets have obliged customers to wear polypropylene single-use gloves in the produce section. To prevent littering, many supermarkets have placed a dedicated waste bin outside each supermarket, monitored by the personnel who regulate the flow of people entering the store. Despite this, a general dispersion of personal protective equipment has been detected in supermarket carparks and other sites where the use of masks and gloves is compulsory. In order to tackle this incorrect behaviour, some mayors have issued local ordinances and imposed a fine up to EUR 500 (Ragazzi et al., 2020).

Figure 3-6 – Littering of single-use face masks on the streets and in the environment

Source: Photographs Oeko-Institut

Unfortunately, discarded personal protection equipment that is found on the streets in cities or stranded on rivers, beaches and coasts (Adyel, 2020; Canning-Clode et al., 2020) eventually ends up in the sea adding to the marine litter problem (Figure 3-6). Kutralam-Muniasamy et al. (2020) notes that ‘it is not possible to estimate the extent of the impact of COVID-19 as there is no robust data on hand for the analysis of trends in marine litter contamination” (Shruti et al., 2020). Meanwhile, face masks and gloves are being introduced as new item to report on for the monitoring and assessment of marine litter (OSPAR, 2020). A first EU-level dataset is expected to become available by the first quarter of 2021. Finally, it is important to mention that landfilling practices can also contribute to littering, especially where open landfills are concerned, as disposed items may be dispersed by the wind to surrounding areas.

While there has been no consistent study of the littering problem associated with COVID-19-related personal protection equipment yet, more and more reports and social media postings are emerging to raise awareness that such littering causes pollution, harms fauna, and contributes to the microplastic problem (Box 3). Environmentalists and researchers warn that fish, crustaceans and birds can ingest soft and flexible plastics, which clogs their digestive tracts, causing premature death. In addition, animals can also become physically entangled, for example in the ear loops of face masks (Hirsh, 2020) or degraded remains. This restrains their mobility and can hinder their ability to feed or escape, affecting their lifespan (i.e. becoming fatally trapped) and their success of reproduction.

Box 3. Example of France: littering of covid19-related plastic items

The French non-profit Opération Mer Propre, for instance, posted photos and video clips on their social media portal of discarded latex gloves, face masks and hand sanitizer bottles found on the shores of the Mediterranean Sea (Opération Mer Propre, forthcoming). In June 2020, Joffrey Peltier of the organization reports that the quantities of masks and gloves found in the marine environment were not yet enormous but may represent ‘a new type of pollution’. Mr. Peltier warns that ‘It’s the promise of pollution to come if nothing is done” (Kassam, 2020). Opération Mer Propre concludes that no coastal region of France has been unaffected from new COVID-19-related waste. In September 2020 for instance, the activists of Opération Mer Propre report that crayfish living in the Berre pond in the Bouches du Rhône became entangled or even fatally trapped with surgical masks floating underwater. The masks cling to rocks, sand, or sea urchins; they are also similar to jellyfish and are ingested by sea turtles (Danger, 2021).

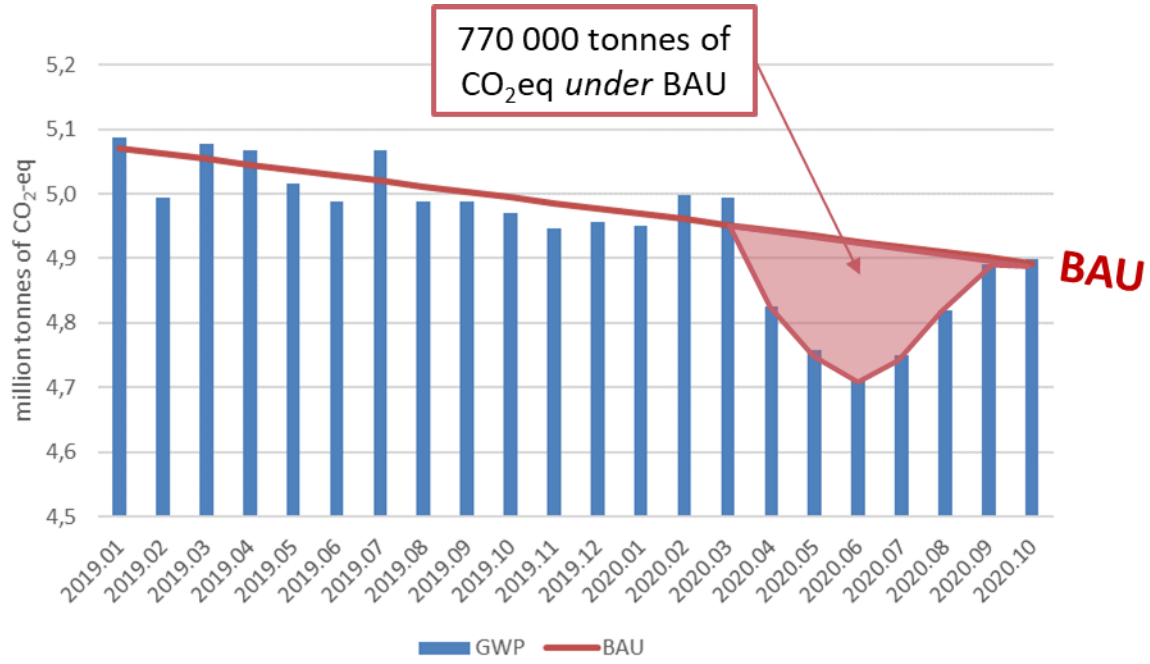
Discarded personal protective equipment is not only suspected to be a significant source of plastic litter in the environment, but also as an additional source of microplastic pollution in the environment, i.e. plastic fragments smaller than 5 millimetres, as larger ‘meso-plastic’ items can get fragmented into smaller pieces. For example, Fadare & Okoffo (2020) have investigated the degradation of single-use face masks in the environment, including the marine environment, at different stages of decomposition. They conclude that plastic fragments smaller than 5 mm are released from degrading outer layer (polypropylene) and inner layer (polyethylene) fabrics (Fadare and Okoffo, 2020). The results suggest that these masks, when released into the environment, represent an additional source of microplastic pollution to ecosystems and the aquatic environment (Aragaw, 2020).

3.3 Impacts of packaging due to delivery and take-away food services

General trends in plastic packaging

For the evaluation of the environmental impacts of the reduced production of plastic packaging in EU-27_{2020} in April-September 2020 compared to the period before COVID-19, the mass flows calculated in section 2.5 (Figure 2-7) are used as a base. Figure 3-7 shows the global warming potential of the plastic packaging production including end-of-life waste management in EU-27_{2020} between January 2019 and October 2020. Other environmental impact indicators show the same trend over the years 2019 and 2020 (see Annex 2).

Figure 3-7 – Estimation of global warming potential (GWP) of the plastic packaging production including end-of-life waste management in EU-27$_{2020}$ between January 2019 and October 2020



Source: Graph by Oeko-Institut, PlanMiljø and IDEA Consult based on Eurostat datasets sts_inpr_m and DS-066341 and ecoinvent 3.6 database

The pre-COVID-19 scenario (business-as-usual) is calculated as the best fit regression line of monthly greenhouse gas emissions from plastic packaging (manufacturing, transport and waste management after usage) in EU-27$_{2020}$ between January 2019 and February 2020, i.e. the 14-month period immediately preceding the arrival of COVID-19 to Europe. This results in an average impact of 5.0 million tonnes of CO_2eq per month, resulting from packaging production in Europe. The COVID-19 scenario is calculated from the average value of the greenhouse gas emissions from plastic packaging between April and October 2020. The net emissions are calculated from the difference between the two scenarios.

As a result of the overall decrease of plastic packaging production in Europe, about 770 000 tonnes of CO_2eq were saved in total between April to October 2020 compared to the business-as-usual situation before that period (decreased by 2.2 % compared to business-as-usual). This corresponds to the annual direct CO_2 emissions of 480.000 EU citizens (due to burning of fossil fuels for home heating and transport)[31].

Single-use plastic packaging for delivery and take-away food services

As described in section 2.5, no reliable data exists to quantify the net effects of changing behaviour patterns as response to the COVID-19 pandemic on the overall single-use plastic packaging by the food services industry. For this reason, it is not possible to evaluate the actual environmental impacts due to changes in this part of the single-use plastic packaging market. However, to give an impression of the potential environmental impacts, different hypothetical scenarios have been assessed, for drink cups on the one hand and take-away food containers on the other hand. For these scenarios, consumption data of the year 2016 in the countries of EU-28$_{2016}$ were taken as basis (Eunomia, 2018).

[31] Based on carbon footprints by Eurostat (2021), which calculated that each EU citizen emitted 1.6 tonnes of CO2eq/person direct emissions in 2019, due to burning of fossil fuels (e.g. for home heating and transport fuel)

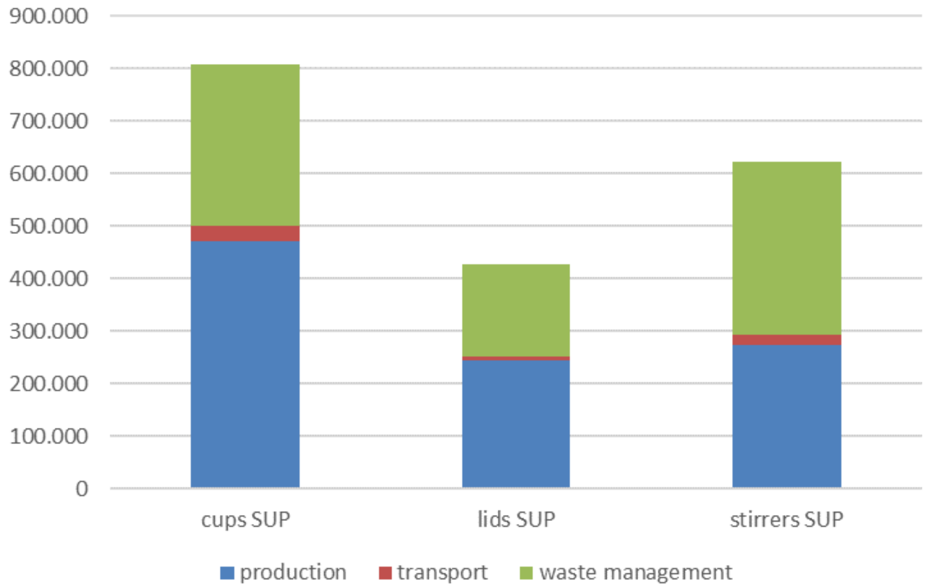
Single-use drink cups, lids and stirrers

For drink cups, around 18.6 billion items made of single-use plastics (12.2 billion paper and plastic lined, and 6.4 billion plastic) and 2 billion items made of single-use non-plastics (cardboard) were consumed in the EU-28 in 2016, along with 21.6 billion lids and 21.6 billion stirrers (Eunomia, 2018). The plastics used in the cups are polystyrene (around 71 000 tonnes, 34 %), polyurethane (8 000 tonnes, 4 %) and paper (around 126 000 tonnes, 62 %), around 65 000 tonnes of polystyrene for the lids and around 130 000 tonnes of polypropylene for the stirrers.

Production is assumed to take place in India mainly and transport to Europe is done by ship. After use, around 1.5 % of the cups and lids were recycled, while the rest and almost all the stirrers end up in the residual waste (Eunomia, 2018). Waste incineration is considered dominant for residual waste treatment in Europe, although in some regions landfill cannot be excluded.

Figure 3-8 shows the total global warming potential (GWP) for the manufacturing, transport and waste management of cups, lids and stirrers in 2016, the reference period for our scenarios. Detailed data for the individual products are included in Annex 2.

Figure 3-8 – Estimated total global warming potential (GWP) for production, transport and waste management of single-use plastics cups, lids, and stirrers in the reference period 2016 (EU-28), in tonnes CO_2-eq



Source: Graph by Oeko-Institut, PlanMiljø and IDEA Consult based on Eunomia 2018 and ecoinvent 3.6 database

Peluso (2020) roughly estimated a decrease of 48% in coffee sales from restaurants and cafés in Europe in 2020. As no specific data was available for the evolution of the on-the-go drink cups consumption in 2020 as response to the COVID-19 pandemic, different scenarios have been calculated, assuming an overall reduction in on-the-go drink consumption (

Table 3-2). The scenarios only consider the impacts of the single-use plastic material of cups, lids and stirrers and do not include further related impacts such as reduced travelling to and from coffee shops.

Table 3-2 – Reduced greenhouse gas emissions compared to 2016 resulting from assumed reduction scenarios for drink cups, lids and stirrers due to COVID-19 pandemic

Assumed reduction of drink cups, lids and stirrers made of single-use plastics in 2020 due to COVID-19 pandemic	Resulting reduced greenhouse gas emissions compared to 2016 [tonnes CO_2eq]
-10 %	186 000
-20 %	370 000
-50 % (based on the estimate by Peluso, 2020)	930 000

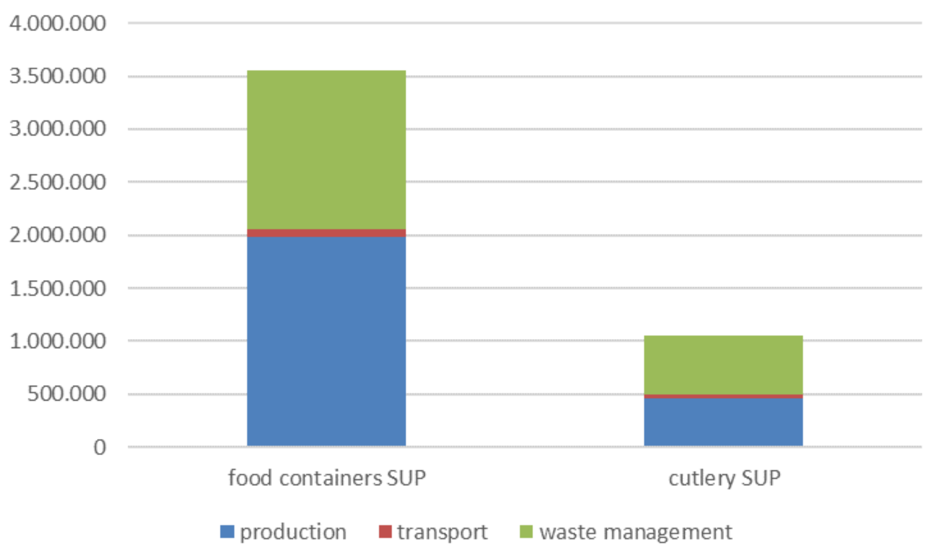
Sources: Calculations by Oeko-Institut, PlanMiljø and IDEA Consult based on Eunomia 2018 and ecoinvent 3.6 database

Food containers and cutlery

For food containers, around 26.3 billion items made of single-use plastics were consumed in the EU-28 in 2016, along with 84.5 billion units of cutlery (Eunomia, 2018). The plastics contained in these products are around 526 000 tonnes of polystyrene for the food containers and around 220 000 tonnes of polystyrene for the cutlery. These values for 2016 were taken as reference, as no information was available for 2019 or 2020.

Figure 3-9 shows the estimated total global warming potential (GWP) for the manufacturing, transport and waste management of single-use plastics food containers and cutlery in 2016, the reference period for our scenarios. Eunomia (2018) reports that around 5 % of the food containers and around 1 % of the cutlery are recycled, while the rest ends up in the residual waste. To calculate the impacts from waste management, incineration is considered for the residual waste. Detailed data for the individual products are included in Annex 2.

Figure 3-9 – Estimated global warming potential (GWP) for production, transport and waste management of single-use plastic food containers and cutlery in the reference period 2016 (EU-28), in tonnes CO_2-eq



Source: Graph by Oeko-Institut, PlanMiljø and IDEA Consult based on Eunomia 2018 and ecoinvent 3.6 database

As no specific data was available for the evolution of the consumption of food containers for take-away food and home delivery in 2020 as response to the COVID-19 pandemic, different scenarios have been calculated, see Table 3-3. On the one hand, an overall increase could be assumed due to closed restaurants and hotels which led to a switch to take-away food and home deliveries instead. On the other hand, less shopping trips, commuting and travelling as well as cancellation of events and festivals could also have led to less take-away meals from these activities.

Table 3-3 – Greenhouse gas emissions compared to 2016 resulting from assumed changing scenarios for food containers and cutlery for take-away food and home deliveries due to COVID-19 pandemic

Assumed changing consumption of single-use plastics food containers and cutlery for take-away food and home delivery in 2020 due to COVID-19 pandemic	Resulting greenhouse gas emissions compared to 2016 [tonnes of CO_2e]
-15 %	-691 000
-10 %	-461 000
+10 %	+461 000
+15 %	+691 000

Sources: own calculations by Oeko-Institut, PlanMiljø and IDEA Consult based on Eunomia 2018 and ecoinvent 3.6 database

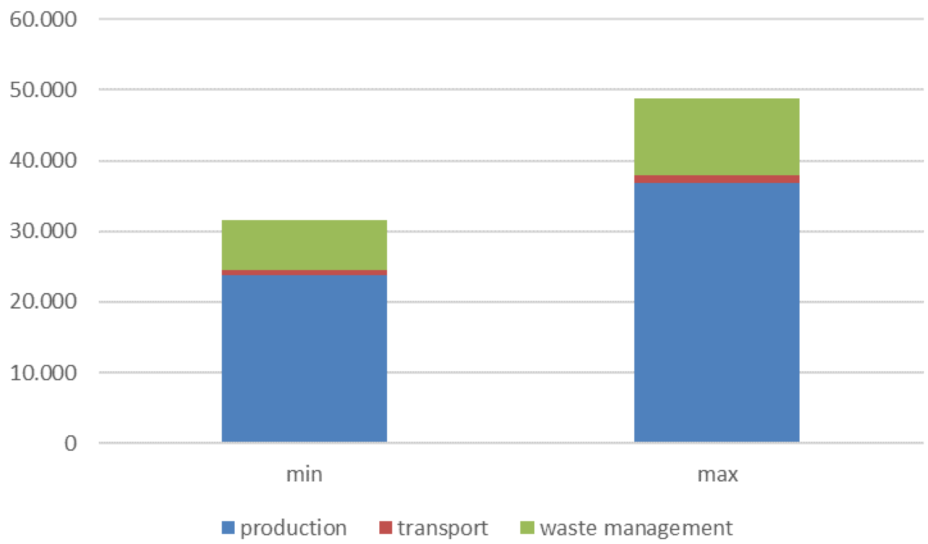
These scenarios only consider the impacts of the single-use plastic material of food containers and cutlery and do not include further related impacts such as reduced travelling to and from restaurants, transport activities of home delivery services, avoided emissions from closed restaurant operations or food consumption. The overall net effect of these systemic and partly contrary trends remains unknown yet.

Single-use plastic packaging for online sales and e-commerce

As described in section 2.5, a range of between 125 000 and 193 000 tonnes of plastic packaging was used for online sales and e-commerce in EU-27 in 2019 (OCEANA, 2020; UNCTAD, 2020). Several plastic types are used for packaging in online sales and e-commerce, including low and high density polyethylene (LDPE, HDPE), polypropylene (PP), polyethylene terephthalate (PET), polystyrene (PS) and expanded polystyrene (EPS).

Figure 3-10 shows the minimum and maximum values for the estimated total global warming potential for manufacturing, transport and end-of-life waste management of the estimated volumes of plastic packaging used in online sales and e-commerce in EU-27 in 2019, which is taken as business-as-usual reference.

Figure 3-10 – Estimated global warming potential (GWP) for production, transport and waste management of plastic packaging used in e-commerce in the reference period 2019 (EU-27), in tonnes CO_2-eq



Source: own graph by Oeko-Institut, PlanMiljø and IDEA Consult based on (OCEANA, 2020), (UNCTAD, 2020) and ecoinvent 3.6 database

As calculated in section 2.5, it is estimated that the quantity of additional plastic packaging used in e-commerce in the period between March-September 2020, amounted to between 11 400 and 17 600 tonnes (9.1 % of the total turnover in 2019). Assuming that this additional turnover was spread evenly across the product types as used by the e-commerce sector in 2019, the additional release of greenhouse gas emissions can be estimated using the same ratio. This leads to an additional emission of between 31 500 tonnes and 48 700 tonnes CO_2eq (+9.1%) above business-as-usual by additional e-commerce activities as response to the COVID-19 pandemic in the period between March to September 2020. 76% of these impacts are related to plastics production, 22% to waste management and 2% to transport.

Waste disposal and management of single-use plastic packaging

While the impacts related to waste disposal of single-use packaging were included in the environmental analysis in the previous paragraphs, some additional observations are highlighted in this section.

About 16 million tonnes of plastic packaging waste is generated annually in the EU, amounting to 31 kg per person. On average about 40% of this packaging waste is separately collected and recycled (European Commission, 2018). ACR+, the Association of Cities and Regions for sustainable Resource management, ran a survey targeting municipal and local authorities and waste operators across Europe to assess the impact of the COVID-19 pandemic on their waste systems (ACR+, 2020). Six out of eight municipalities that responded, identified a reduction in plastic packaging waste in May 2020 compared to May 2019 with four of these reductions being significant (between 5 % and 30 %). On the contrary, in a study carried out by Municipal Waste Europe, some members reported an increase in the share of plastics in municipal waste and industrial waste, caused by hygienic requirements on use of plastic bags and gloves in response to COVID-19 (Municipal Waste Europe, 2020).

Several studies reported a shift in waste production from industry to households as a result of the COVID-induced shift to staying and working at home (Municipal Waste Europe, 2020; BDE, 2020) (Box 3).

Box 3. Increase in German household waste and decrease in commercial waste

The German Federation of Waste Management Organisation (BDE)[32] carried out a survey of its waste management company members on the effects of COVID-response measures on waste composition and quantities in Germany between March and November 2020.

With an annual volume of 30 kg per person, the share of so-called light packaging is the largest volume stream among the waste types surveyed. Every year, German waste companies collect about 2.5 million tonnes of light packaging made of plastic, metal and composite materials from private households. As a result of the COVID19-pandemic and the more intensive domestic life, German waste companies reported a shift in waste composition. Some members recorded an increase of 20 % in light packaging waste from private households during the first wave of lockdowns in March to May 2020, while the waste volumes from industry, trade and commerce declined sharply. Following the partial reopening of society in summer 2020, waste generation by households dropped rapidly again to their initial quantities. For the year 2020 as a whole, the companies see an increase in the volume of light packaging made of plastics, metals and composite materials by 5.7 % at the time of the survey, expecting a further increase in light packaging waste volumes in December 2020 of around 8%.

Source: BDE (2020)

[32] Bundesverband der Deutschen Entsorgungs-, Wasser- und Rohstoffwirtschaft e.V.

4 Addressing impacts of COVID-19 on single-use plastics and the environment: status and future options

This chapter exemplifies measures that were taken throughout Europe by different actors for addressing and coping with the impacts of the first wave of COVID-19 on changing consumption of single-use plastics and related effects on the environment. Examples presented below include guidelines or policies put in place by national governments or municipalities, business initiatives using circular business models, research activities as well as consumer-initiated actions. Reflecting on these measures and initiatives, some cross-cutting considerations and potential future options are presented to deal with these environmental and climate impacts in the longer term.

4.1 Single-use plastic medical protection equipment

Policies put in place by governments and municipalities

With most European cities making face masks mandatory in public transport and in public spaces at different times in 2020, Member States encouraged mask usage and made them available in different ways. Especially in the initial phase of the pandemic, European production capacity was limited. Several governments have responded, for example, by calling on their industries to either expand their existing production capacity or switch to the manufacturing of medical protection equipment.

While most governments implemented across the EU similar rules and guidelines, local differences exist. Below are some examples of how national governments aimed to facilitate manufacturing, supply, (re)use and waste management of face masks during the pandemic (Box 4).

Box 4. Examples of government actions across Europe to support the manufacturing, supply, (re)use and safe disposal of face masks

Belgium

The Belgian government issued national guidelines, while enforcing specific restrictions on businesses and citizens was delegated to municipalities. As a result of the mask shortage experienced in the first months of the pandemic, single-use masks were being reserved for health workers and citizens were encouraged to manufacture their own reusable textile masks at home. From June 2020 on, each citizen could pick up one reusable mask for free at the local pharmacy. Additionally, some municipalities distributed reusable masks among their population, based on the number of people registered at each address. As the mask shortage resolved after June 2020, using reusable masks was no longer actively encouraged by the Belgian government. On the contrary, by the end of 2020, there are examples of several hospitals that made single-use masks mandatory for visitors due to hygiene concerns. Some municipalities have made efforts with volunteers to collect face masks littered in public spaces.
In April 2020, as severe mask shortages threatened hospital operations, the Belgian Federal Agency for Medicines and Health Products (FAGG) published a national guideline on the sanitation of disposable surgical masks and FFP masks in order to enable their reuse (Federal Agency for Medicines and Health Products, 2020). It is unclear -but improbable- if these practices still prevailed as soon as mask supply issues were solved.

Estonia

The Estonian government asked local companies to manufacture reusable masks, while encouraging citizens to use them. In order to counter rumours that reusable masks do not offer adequate protection, initiatives were taken to test different types in the laboratory and publish the results about their performance.

France

In April 2020, the use of masks (reusable or single-use) in public spaces was mandated. Although the government advocated the use of reusable masks, the official government's guidelines advised to throw away masks after one use (Connexion, 2020). As a result, France experienced heavy littering in public spaces, especially from reusable masks being disposed of improperly. For example, the city of Tours (300 000 inhabitants) generates about 80 tonnes of mask waste per month. To manage the waste, 200 collectors have been installed throughout the city, consisting of two separate collection tubes for surgical masks and fabric masks. Although the aim is to recycle the used masks, at this stage, very few companies recycle masks (Pouvrea, 2020).

Germany
Since end of April 2020, Germany has introduced a nationwide obligation to wear 'community masks' in public transport and shops. Due to mask shortages in the early stage of the pandemic and to safeguard the availability of protective masks for medical facilities, there was increased reliance on reusable textile masks for the general population. In January 2021, the German government restricted the use of these 'community masks' and introduced the obligation to wear standardised surgical masks or FFP2 masks in public transport, shops and offices. Additionally, an national action was set up mid-December 2020 to equip elderly people or those with pre-existing conditions with FFP2 masks, supplied at pharmacies, using a system of coupons (Wolf, 2020).

Spain
Spain was among the countries with the strictest national lockdown measures in the EU during the first wave of the pandemic. After that, the different autonomous communities applied different restriction regimes. The use of masks was encouraged in public spaces and in some instances imposed in public transport. The government called on their local textile industry to manufacture reusable face masks in order to overcome shortages and reduce import dependency. Supported by government investments and logistics supplied by the national armed forces, Spain increased its production capacity to manufacture 60 million reusable masks between April and October 2020 (Ormazabal, 2020).

Source: Online workshops, 9th December 2020 and 13th January 2021

Business initiatives including circular business models

Examples of circular business models in relation to single-use medical protective equipment are mainly on a small scale. Only few individual companies have taken the initiative to develop circular practices, driven by sustainability considerations or following consumer demand (Box 5). A major challenge to the reuse and recycling of medical protection products is to guarantee adequate product sanitation to eliminate the risk of infection.

Box 5. Examples of circular business initiatives

Belgium: collection and recycling of single-use face masks
The supermarket chain Carrefour has started a partnership with TerraCycle and Suez group aimed at the collection and recycling of used masks into new plastic products. Customers can drop off their used masks in a dedicated box at the supermarket entrance. Afterwards, TerraCycle cleans and processes the collected masks into granules that can be used to manufacture garden equipment, such as outdoor furniture, watering cans, garbage bins, construction tubes, etc. (Stambouli, 2020).

France: recycling of single-use face masks
The SME Plaxtil, based in Châtellerault, has set up an additional branch in Poitiers to recycle used masks into rulers to be distributed in schools (Fleurot, 2020).

Switzerland: reusable face masks certified according to EN 14683:2019
A Swiss company developed a technology that continuously inactivates >99.9 % of the exhaled SARS-CoV-2 viruses, aimed to improve the protection performance of reusable textile masks. The company offers a surgical face mask model according to standard EN 14683:2019, which can be washed up to 30 times and which, according to the manufacturer, replaces 210 disposable masks (with weekly washing) (Livinguard, 2021). Other companies across Europe have developed similar reusable masks (Ecodry, 2021; Mo, 2021; Proveil, 2021).

Whereas the circular business models exemplified above mainly target private consumption of single-use face masks, circular economy approaches could also be conceivable for in the healthcare sector where a great number of single-use plastics is used, both as packaging and other single-use plastics. According to the Swedish Environmental Protection Agency there is a potential for circular business models based on recycling products made from pure polyethylene and polypropylene and which are not in contact with patients, if they could be sorted into flows that are large and clean enough (Ljungkvist Nordin and Westöö, 2019).

Research

Most of the research that emerged during the pandemic on medical protective equipment seemed initially focused on hygienic aspects rather than on material recyclability, impacts on the environment, or waste management (Patrício Silva et al., 2021). Some recently published scientific papers dealing with environmental impacts of single-use personal protective equipment at European level are listed (Box 6).

Box 6. Research on the environmental impacts of medical protective equipment related to COVID19

Implications of increasing demand for face coverings arising from COVID-19 on their efficacy, re-use and sustainable waste management (Rowan & Laffey, 2021)
Researchers analysed different approaches and reprocessing technologies to solve shortages in the supply chain of personal protective equipment during the early stages of the COVID-19 pandemic, as well as measures to improve resource use, potential alternative bio-based plastics and waste management practices to address the environmental impact of the increased use of personal protective equipment.

Policy solutions based on redesign and reduction of single-use plastics and personal protective equipment (Patrício Silva et al., 2020)
Researchers published a paper on rethinking and optimising plastic waste management in the context of the COVID-19 pandemic, the need to reinforce and implement plastic reduction policies, to scale up innovation aimed at sustainable plastics solutions, and to immediately develop dynamic and responsive waste management systems. The paper discusses the readjustments of existing plastics policies in response to the COVID-19 pandemic along with their potential environmental implications.

Minimising the present and future plastic waste, energy and environmental footprints related to COVID-19 (Fleurot, 2020; Klemeš et al., 2020)
The researchers assess the impact of the COVID-19 pandemic on the life cycles of various plastic products used in health care, pointing out the issues related to the destruction of residual pathogens in household and medical waste. Several research directions are suggested to mitigate the potential impacts of the pandemic on waste management systems. The proposals include ‘disaster waste management”, i.e. collection and treatment technologies (e.g. remote-controlled robots), infrastructure, capacity, logistics, safety and regulatory aspects linked to the bio-disaster response; disaster waste management planning on the regional scale instead of limited to the local level; incorporation of social factors and uncertainties in techno-economic assessments; and better trade-offs between medical/healthcare plastics and regular single-use plastics to control the total amount of hazardous waste.

The role of consumers

The role of consumers under pandemic situation can be seen as ambivalent in terms of personal health protection needs on the one hand and environmental impacts caused by using single-use protective equipment on the other hand.

In the first months of the pandemic, several governments encouraged citizens to manufacture their own reusable, textile facemasks. However, this was rather a direct result of a general shortage of medical face masks in Europe than under the premise of a circular economy avoiding waste from single-use plastics. After mid-2020, when shortage of mask supply was largely resolved, reusable masks and especially self-made masks were no longer encouraged by governments, as was the case e.g. in Croatia, Belgium, Spain and Germany, or they were even prohibited to use in public spaces, which has been the case e.g. in Germany with the obligation to wear medical or FFP masks since January 2021. Until more sustainable alternatives for personal protective equipment with the same level of health protection are proven and available, consumers' options to reduce the use of disposable face masks are limited.

Consumers have an important role in terms of proper disposal of personal protective equipment such as masks and rubber gloves to assure proper waste management. It is clear that authorities have the responsibility to provide adequate disposal options. In any case, littering should be prevented. In this context, on the other hand, reported examples of voluntary citizen efforts to collect littered face masks and gloves from nature can be mentioned.

Examples of potential further actions to be undertaken across the EU

Whereas the previous sections exemplified several European activities of national governments, municipalities, businesses, researchers and citizens to address COVID-19 related environmental impacts of personal protective equipment, further ideas and options for more consolidated action are listed in Box 7.

Box 7. Further ideas and options to address environmental impacts of single-use medical protective equipment across Europe

Research: In order to accurately assess and reduce the potential environmental impacts of single-use plastics based personal protective equipment, further research is needed on:

- Alternative material for face masks under the premise of best combining hygienic and environmental aspects, supported by hygiene and lifecycle assessments (e.g., comparison of single-use masks with reusable masks, exploring different designs and materials (virgin, recycled or biobased plastics, cotton or other natural fibres, etc.) in combination with proper sanitizing and waste treatment.
- Strategies to encourage desirable consumer behaviour related to personal protective equipment, including correct use, sanitation, collection, safe disposal and the prevention of littering
- Environmental impact of plastic litter in public spaces and nature
- Technology options for sanitizing reusable masks
- Recycling options for single-use personal protective equipment

Monitoring: More accurate and timely monitoring (i.e. at shorter intervals) of certain aspects is needed in order to facilitate research and guide future policy options, such as

- More specified, up-to-date data collection on production and trade of certain personal protective equipment categories
- Data collection on littering of personal protective equipment, including littering originating from landfills

Policy: Based on improved monitoring and research, policy options to address environmental impacts of single-use medical protective equipment include:

- Europe-wide awareness raising on environmental and hygiene aspects of personal protective equipment, using harmonised consumer information to avoid confusion due to diverging messages.
- Policy support and incentives for emerging circular business models which combine hygienic requirements and environmental considerations of personal protective equipment, e.g. development of hygienic reusable masks, or collection and recycling approaches for waste.
- Policy support for effective municipal waste management of personal protective equipment, e.g. clear guidelines and procedures to apply during pandemics regarding waste reduction recommendations, protective measures, collection frequency and effective end-of-life treatment

4.2 Single-use plastic packaging

Policies put in place by governments and municipalities

The closure of restaurants and non-essential physical shops in many countries in Europe during the first and second waves of the pandemic and the resulting shift towards take-away and home-delivery food services as well as increased e-commerce is expected to have had effects on the consumption of plastic packaging used in these sectors and the related environmental impacts.

In contrast to the guidelines on personal protective equipment, there have been no clear European or national guidelines or policies in place to regulate the use of plastic packaging in the food services and e-commerce sector. On the contrary, due to hygienic concerns some official guidance even prohibited or advised against the further use of reusable food packaging systems that were in place before COVID-19. At the same time, some governments continue their pre-pandemic efforts for a shift to reusable packaging, despite the continuation of the pandemic (Box 8).

Box 8. Two examples of national guidance on the use of single-use packaging in relation with the COVID19 response

Belgium: contradictory advice regarding reusable packaging by different government levels
Although the Belgian national food safety agency (FAVV/AFSCA) did not prohibit the use of reusable packaging in food services, it advised against as a precautionary measure (FAVV, 2020). On the other hand, the regional public waste agency of Flanders, OVAM, published on their website guidance on 'COVID-19 and reusable catering materials" pointing out on the environmental impacts of single-use packaging and providing recommendations on good hygiene practices to be applied under pandemic conditions (OVAM, 2020).

Germany: amendment of national packaging legislation
Despite the prevailing pandemic situation, the German Federal Government has passed an amendment of the national packaging legislation on 20 January 2021, requiring reusable systems from 2023 onwards. Restaurants, bistros and cafés that sell food or drink to-go are obliged to provide the possibility of reusable packaging. The reusable variant must not be more expensive than the product packaged in disposable packaging. Reusable cups must be available for all sizes of to-go drinks (Schneider, 2021).

Business initiatives including circular business models

The restaurant industry was affected most immediately as restaurants were the first ones to be closed during lockdowns in the EU. Corporations like for example, Starbucks, which had recently reacted to the call to phase out plastic cups, banned the practice of filling drinks in reusable cups and returned to plastic/paper cups (Flint, 2020; Ji, 2020). Similarly, as restaurants had to adapt their business model in response to closures, many of them started offering take-away or food delivery services, which probably led to an increase in single-use plastic food packaging, while at the same time reusable food packaging solutions were discouraged due to hygienic concerns.

Box 9 illustrates a circular business model allowing a continued use of reusable food packaging, even under pandemic conditions.

Box 9. Example of Germany: digital reusable packaging system for take-away meals

To reduce the environmental impacts of single-use plastic packaging caused by take-away food, the German start-up company Vytal developed a digital reusable system via a smartphone App and a QR-Code. The system is free of costs for the customer but financed and operated via a filling fee paid by the restaurants and canteens. The food containers and cups are expected to be used up to 200 times. The dish can be returned to all participating system partners within 14 days. There they will be checked, scanned again and then sanitised in the gastro dishwasher for the next use. Only if the containers are not returned after 14 days, a fee of EUR 10 will be charged to replace the dish (Vytal, 2021).

Research

In neither of the sectors of food services nor e-commerce, emerging research could be observed specifically tackling the environmental impacts of the resulting additional plastic packaging consumption in response to COVID-19. However, research in this area would be very useful, especially since there is an overall lack of specific and systematic data on volumes and composition of plastic packaging consumption related to the food delivery and e-commerce sectors. Such data could constitute the basis for further research into the economic and environmental impact of single-use plastics and alternative packaging solutions in the restaurant and food sector.

One example of research identified deals with different scenarios of how the vision on plastic packaging recycling might change after the global pandemic (Kahlert and Bening, 2020). In order to turn the COVID19 crisis into a game changer for the plastics industry, some researchers urge policymakers to include the long-term targets of the European Green Deal in their decision making on short-term measures to alleviate the crisis. Assuming plastics upholds its important role as a packaging material, this will require that sustainability and circularity ambitions are not scaled back and recycling targets should not be postponed.

The role of consumers

With travel restrictions in place and more people staying at home during the pandemic, individual consumers experienced important disruptive effects. The potential job loss for citizens resulted in financial uncertainty and an overall reduction in consumption. On the other hand, e-commerce saw an additional increase during the pandemic months, resulting in additional plastic packaging consumption. In several Member States consumers were instructed to avoid reusable bags and containers for groceries in particular. On the other hand, some existing 'packaging free' shops who promoted reusable packaging systems before the pandemic, indicated an increase in sales[33].

For the plastic packaging consumption of the food services and e-commerce sector, consumers currently have more flexibility and options for reducing the related environmental impacts than for personal protective equipment. Examples include shopping at 'packaging free shops', at local retailers (with several of them quickly initiating web platforms to offer 'click & collect" services for their customers), cooking at home (while official statistics and polls are still being analysed, it is likely that 2020 will see a significant increase in meals cooked at home according to (Standrige and Ray, 2021)), or supporting restaurants and retailers that still offer reusable food packaging concepts under strict hygiene conditions.

Examples of options for actions to be undertaken across the EU

Whereas the previous sections exemplified several European activities of national governments, municipalities, businesses, researchers and citizens to address COVID-19 related environmental impacts of single-use plastic packaging consumption, with a focus on the take-away and food services and e-commerce sector, further ideas and options for more consolidated action on single-use plastic packaging are listed in Box 10.

Box 10. Examples of options for actions to be undertaken related to single-use plastic packaging

Research: In order to accurately assess and reduce the potential environmental impacts of single-use plastics packaging, further research is needed on:

- Changing consumer habits and effects due to restrictions of COVID-19 pandemic on consumption of food and other goods and the related single-use plastic packaging
- Hygienic safety of reusable packaging systems for food and other products
- Continuing the ongoing research on and application of reusable alternatives for single-use plastic packaging materials, e.g. bags and filling materials used in transport.

Monitoring: More accurate and timely monitoring (i.e. at shorter intervals) of certain aspects is important in order to facilitate research and guide future policy options, such as

- Statistical data specified on the use of single-use and reusable packaging in a variety of consumption sectors (e.g. food, health care, textiles, durable goods) could help monitoring the status and progress of circularity in the field of packaging, while measures and solutions to improve sustainability could be tailored to the specific consumption domains.

Businesses:

- Companies could be encouraged to develop circular models for packaging, such as reusable packaging for food and other goods, take-back and redistribution systems for reusable packaging, sanitizing processes to assure hygiene and safety and efficient collection and recycling schemes.

[33] Online workshop 9th December 2020

- Packaging industries could be encouraged to develop packaging from recycled or low-impact materials, and that can easily be recycled at end of life, e.g. packaging made of recycled cardboard, paper, wood or biowaste, or biodagradable packaging

Policy: Based on improved monitoring and research, policy options to address environmental impacts of single-use plastic packaging include:

- Europe-wide awareness raising on the environmental impacts of packaging, behavioural changes to reduce packaging waste and shift to reusable packaging systems, including adequate information and guidelines on hygiene aspects and sanitation
- Policy support and incentives for emerging circular business models which combine hygienic and environmental aspects of reusable/sustainable packaging alternatives in retail and food delivery.
-
- Regulatory initiatives on reducing environmental impacts of single-use plastic packaging could be investigated, e.g. promoting the use of recycled or low-impact materials, or the setup of packaging recycling schemes, including collection, sorting and high-quality recycling of packaging waste.

4.3 Reflections on the way forward

Besides specific actions on single-use medical protection equipment and plastics packaging for food delivery and e-commerce as proposed in chapters 4.1 and 4.2, some further cross-cutting reflections on future policy options are given below.

Filling data gaps

The unexpected outbreak of the COVID-19 pandemic has forced huge changes in usual consumption and business patterns and created significant challenges and uncertainties worldwide. The initial lack of knowledge and experience regarding the ways in which the virus spreads and the need to protect the population from infection led to a prioritisation of health concerns. As a result, the majority of public awareness campaigns, research and scientific publications on COVID-19 predominantly addressed health protection aspects rather than the effects on waste and plastic pollution.

Since many statistical data systems are based on annual data collection short-term data were often not available to display the immediate effects of the transitions induced by the pandemic. Also, as some of the products in focus of this study are considered part of much broader product clusters, specific data on production, trade and consumption was not available, or not detailed enough to analyse the environmental impacts, e.g. data on overall plastic packaging consumption specified per material type and per sector (e.g. take-away and food services and e-commerce). Furthermore, single-use plastic products such as face masks and gloves were initially not part of monitoring systems on littering.

Policy options aimed at filling these data gaps can be, for example, including more specific data on the share and type of single-use plastic items into national and European monitoring and reporting frameworks on production, trade, consumption, littering and waste management. Also, further research and lifecycle assessments are needed on safe and more sustainable material and systems solutions for single-use and reusable packaging, as well as for single-use goods, including research on what type of circular business models and systems are suitable to assure their collection, take-back and waste management. Based on such data, consolidated consumer information on sustainable alternatives, hygienic reuse practices and sound waste disposal can be provided, while raising public awareness on the adverse effects of plastic pollution in the environment. Finally, since plastic pollution is not restrained by political boundaries and has a global impact, international cooperation is essential, especially in the sharing of knowledge, technology, and funding (Patrício Silva et al., 2020).

Financial triggers to facilitate circular economy approaches

Several industry sectors, hit hard by restrictions during the lockdowns, are struggling to cope with the economic effects of the COVID-19 crisis, and may continue to suffer in the years to come as effects of the pandemic linger. In response to demand reductions for plastics packaging and other types of plastic products, the industry asked for, among other things, a freeze of all non-essential regulatory initiatives concerning plastics to support the recovery of the industry and avoid additional compliance costs for companies. Such considerations have led, for example, to the postponement of Italy's plastics tax of €0.45 per kilo on non-recyclable plastic packaging that was due to enter into force on 1 July 2020 (Laird, 2020).. Still, in order to further develop the plastic recycling market in the future, support its profitability and reduce the use of virgin plastics in Europe, initiatives like these will remain necessary (Pool, 2020). Further financing instruments are planned, e.g. in the Circular Economy Action Plan (European Commission, 2020). For example, existing or envisaged fees, taxes and bans on fuel-based single-use plastic products can incentivise a shift from the use of virgin plastics to recycled plastics. Policy options and financial incentives aimed at reducing COVID-19 related environmental and climate impacts of single-use plastic products can include, for example, incentives for developing reusable/sustainable alternatives for personal protection equipment; supporting effective collection and municipal waste management and improvement of recycling streams for personal protection equipment; or re-establishing reusable/sustainable packaging alternatives that comply with hygiene requirements in retail and food delivery. Even during a pandemic, financial incentives and policy support should still be guided by the priorities of the waste hierarchy (i.e., refuse, reduce, reuse, repurpose, recycle).

Preparing for future disrupting events

The COVID-19 pandemic emphasised the dependence of European, society on disposable plastics and disclosed the fragility of plastic reducing policies and the waste management system. Some changed consumption and disposal habits will likely prevail long-term, even post-pandemic and so will their adverse effects to the environment, such as a shift from reuse and recycling to single-use and incineration or landfill (Patrício Silva et al., 2020).

The global COVID-19 pandemic has also exposed the vulnerabilities of long supply chains and the resource intensity of large industries. One structural change that NGOs and research organisations are advocating is the implementation of shorter industrial supply chains which would facilitate closing loops by reducing the distance between production and waste treatment. Developing environmentally sustainable and circular models is becoming a priority of many policies (Kechichian and Mahmoud, 2020). This is further supported by recent research that showed that companies that adhere to sustainable and circular practices suffered less from lockdowns and travel restrictions than companies using conventional methods and market practices (Hew, 2020; Vrancken and Mouligneau, 2020).

Therefore, one of the key conclusions of this study is that the lessons learnt from the current pandemic can be a trigger to rethink and optimise plastic consumption and waste management practices, in order to make our society less vulnerable and better prepared to potential future pandemics, raw material shortages or disruptive events.

5 Conclusions and further reflections

The global COVID-19 pandemic has tremendous impacts, not only on health, but also on changing lifestyles, consumption patterns, supply chains, economics, and on the environment. In the light of Europe's overall efforts on reducing impacts of single-use plastics as one of the main targets of the Circular Economy Action Plan and facilitated by the implementation of Directive (EU) 2019/904 on Single-use Plastic Products, this study aimed to assess the specific transitions and effects of the COVID-19 pandemic on the consumption, production and trade of single-use plastics in Europe, as well as the related environmental and climate impacts.

While many types of single-use plastics may have been affected directly or indirectly by the response to the COVID19 pandemic, the analysis focused on medical protection equipment made of single-use plastics aimed at tackling COVID19, i.e. face masks and gloves, and on single-use plastic packaging, specifically those used in e-commerce and food take-away and delivery services. The study calculated the COVID-19 related changes in consumption, trade and production in the period April to September 2020 (plus October, where data were available). Since recent data sources covering the period January-September 2020 are relatively sparse, and available data sources are often not designed to distinguish between 'single-use' and 'multi-use' plastics, many approximations were needed to distill and quantify emerging trends, e.g. extrapolations from historic data, estimates on shares of single-use plastics and end uses, assumptions on material composition, assumptions on changed consumer behavior, etc. Also, overlaps or gaps when comparing or combining different data sources could not be excluded, nor could net effects be quantified for products where changes in consumption pulled in different directions. One should also be aware that there could be hidden or indirect effects of the COVID response that are not taken into account at this stage. In view of these limitations, the results should be interpreted with caution.

One of the most visible effects of the pandemic was a surge in the demand for disposable protective equipment made of plastics, such as face masks and gloves – not only used in medical environments, but as personal protection equipment for the general population. The net imports to the EU-27, over and above business-as-usual, totaled 170 000 tonnes for face masks and 105 000 tonnes for plastic (including rubber) gloves. This is estimated to have caused an additional global warming potential of about 2.4-5.7 million tonnes of CO_2eq due to the production, transport and waste treatment of face masks and about 1.5 million tonnes of CO_2eq due to single-use gloves released between April and September 2020. These emissions depend highly on the product design and the constituting materials, as well as on the transport mode. Also, since production typically takes place outside Europe, an important part of these emissions are released outside Europe.

Another consequence of the pandemic was a significant reduction of the plastic packaging production in $EU\text{-}27_{2020}$ during the period April to October, with approximately 227 000 tonnes. This results in a saving of about 770 000 tonnes of CO_2eq (-2.2 % compared to business-as-usual). It is important to note that not all of these packaging products are single-use plastics. Also, EU consumption of packaging in 2020 could not be estimated at the time of writing of this study since import and export data of plastic packaging were not yet available. Potential changes in consumption of two specific types of single-use plastic packaging were investigated in more detail: single-use packaging for food take-away and delivery services and e-commerce packaging.

Overall net effects for single-use plastic food and drink packaging is difficult to estimate as no reliable data on the net demand was available. Also, expected effects pull in different directions: on the one hand increased working and studying from home, reduced travelling and cancellation of leisure activities and events resulting in less on-the-go consumption of food and drinks. On the other hand, take-away and home delivery consumption due to restrictions of eating-in at restaurants and cafés increased. A scenario assuming a reduced consumption of drink cups including lids and stirrers by 50 % would have led to reduced emissions of 930 000 tonnes of CO_2eq; assuming an increased consumption of food containers for take-away and deliveries by 10 % would have led to additional emissions of 461 000 tonnes of CO_2eq compared to business-as-usual consumption, for the studied period.

At the same time, the temporary closures of shops during the lockdowns resulted in further shift to online shopping with an additional COVID-19 related turnover of the e-commerce industry of 9.1 % above business-as-usual in the period April to September 2020 compared the total turnover in 2019. This resulted in an additional quantity of between 11 400 and 17 600 tonnes of plastic packaging, corresponding to an additional greenhouse gas emission of about 33 500 to 51 700 tonnes of CO_2eq in the period April to September 2020.

The changing use of single-use plastics for personal protection equipment, plastic packaging for food and drinks as well as e-commerce has also impacts on further impact categories such as acidification potential, eutrophication or fresh-water aquatic ecotoxicity, corresponding to the same trends as shown for the global warming potential. Furthermore, initial effects of the COVID-19 pandemic on waste generation could be observed, such as changing composition of municipal waste due to changing consumption patterns and lifestyles, as well as littering of single-use face masks and gloves in the streets or in the environment. While the change in waste composition was too limited to significantly impact waste treatment practices, littering may present a bigger problem which is well documented in situ but still needs to be further assessed in quantitative terms. Also, the environmental effects of littering still need to be better understood, as littered masks do not only harm animals through entanglement or ingestion, but also represent an additional source of microplastic or nanoplastic pollution.

When the pandemic hit Europe early 2020, most responses of governments and municipalities, as well as research efforts, understandably, focused first and foremost on hygienic and health aspects related to COVID-19 whereas environmental aspects associated with changing single-use plastic consumption were not in focus. On the contrary, many reusable packaging systems in place for food and drinks were discontinued as a precaution due to hygienic concerns. On the other hand, triggered by the very visible additional waste generation of single-use face masks and gloves, a number of local authorities, non-governmental and business initiatives, as well as research, started to highlight the increasing environmental impacts. Solutions were initiated, such as monitoring and collection of the littered face masks, lifecycle assessments of reusable textile face masks, research into the efficacity of different material types of face masks, separate collection and recycling of single-use face masks, and others.

Expectations are that the global COVID-19 pandemic will still continue into 2021 and potentially beyond. As a result, the transitions in lifestyles, consumption patterns and supply chains it initiated will further endure, while some changes may even last after the pandemic is over. In order to limit the impacts on the environment, there is a need to review the practices and activities undertaken so far and strengthen the focus on further monitoring, research, business initiatives and policy options that contribute to Europe’s overall objective on reducing impacts of single-use plastics as one of the main targets of the Circular Economy Action Plan. Also, the global COVID-19 pandemic has also exposed the vulnerabilities of long supply chains and the resource intensity of large industries. The implementation of shorter industrial supply chains would facilitate closing loops by reducing the distance between production and waste treatment. Therefore, one of the key conclusions of this study is that the lessons learnt from the current pandemic can be a trigger to rethink and optimise plastic consumption and waste management practices, in order to make our society less vulnerable and better prepared to potential future pandemics, raw material shortages or disruptive events.

List of abbreviations

Abbreviation	Name
AP	Acidification potential
BAU	business-as-usual
CE	Circular Economy
CEAP	Circular Economy Action Plan
DG GROW	Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs
DS	Data set
EEA	European Environment Agency
EP	Eutrophication potential
EPS	Expanded polystyrene
FFP	Filtering face peace
FWAET	Fresh water aquatic ecotox.
GDP	gross domestic product
GWP	Global warming potential
HDPE	High Density Polyethylen
HOTREC	Hotels, Restaurants, Cafés
HTP	Human toxicity potential
LCA	Life-cycle assessment
MAETP	Marine aquatic ecotoxicity
MSW	Municipal solid waste
ODP	Ozone layer depletion potential
OECD	Organization for Economic Co-operation and Development
PE	polyethylene
POCP	Photochemical oxidation potential
PP	polypropylene
PPE	Personal protection equipment
PS	polystyrene
QR	Quick Response
RMSW	Residual municipal solid waste
SME	Small and medium enterprise
SUP	Single-use Plastics
TAETP	Terrestrial ecotoxicity
UK	United Kingdom
WHO	World Health Organisation

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Annex 1 – Methodological approach / data sources

A1.1 Methodology to calculate the total plastic packaging production as displayed in Figure 2-7.

Source for monthly data: Eurostat dataset [sts_inpr_m]

- Volume index of production
- C2222, Manufacture of plastic packing goods
- Seasonally and calendar adjusted data
- Index, 2015=100

Source for total tonnes in 2015 (yearly data): Eurostat database [DS-066341], considering the following codes (subcodes of C2222, Manufacture of plastic packing goods)

Table A1-1 – Prodcom subcodes considered for calculation of total plastic packaging production

PRCCODE	Unit	PRCCODE_LABEL
2222.1100	kg	Sacks and bags of polymers of ethylene (including cones)
2222.1200	kg	Plastic sacks and bags (including cones) (excluding of polymers of ethylene)
2222.1300	kg	Plastic boxes, cases, crates and similar articles for the conveyance or packing of goods
2222.1450	p/st = number of items	Plastic carboys, bottles, flasks and similar articles for the conveyance or packing of goods, of a capacity <= 2 litres
2222.1470	p/st = number of items	Plastic carboys, bottles, flasks and similar articles for the conveyance or packing of goods, of a capacity > 2 litres
2222.1910	kg	Spools, cops, bobbins and similar supports, of plastics
2222.1920	kg	Plastic caps and capsules for bottles
2222.1925	kg	Plastic stoppers, lids, caps, capsules and other closures
2222.1930	kg	Plastic stoppers, lids, caps and other closures (excluding for bottles)
2222.1940	kg	Plastic netting extruded in tubular form
2222.1950	kg	Articles for the conveyance or packaging of goods, of plastics (excluding boxes, cases, crates and similar articles; sacks and bags, including cones; carboys, bottles, flasks and similar articles; spools, spindles, bobbins and similar supports; stoppers, lids, caps and other closures)
2222.1990	kg	Other articles for the conveyance or packing of goods of plastics

Assumptions for the conversion of p/st to kg:

- 22 221 450 (< 2L): specific weight in g per item: 36.4 (neue verpackungen, 2002)
- 22 221 470 (> 2L): specific weight in g per item: 250 (Glas-Shop.com, forthcoming)

Source for data on plastic packaging waste generated in 2015 (for the purpose of validation of the data): Eurostat data set [ENV_WASPAC]

A1.2 Interviewed organisations and interview questions

Interviewed organisations:

- ACR+
- Municipal Waste Europe
- European Plastics Converters

Interview questions for ACR+:

- Have you received any results yet from your survey of members on COVID-19? https://acrplus.org/en/municipal-waste-management-COVID-19. Based on this or other information can you please see if you can answer any of the following questions:
- Have your members seen changes in the type and volume of Single Use Plastics (SUP) that they receive in municipal waste since the beginning of the pandemic? (*both in separately collected plastics or mixed waste)*
- Have the volumes of SUP in household versus commercial waste changed? If so, how?
- Is SUP protective equipment found in separately collected plastic waste streams causing problems with respect to recycling technologies and markets? How and why (*difficult material composition of for example face masks, fear of contamination, etc.)*
- Have your members observed any changes in the prevalence and type of littering by SUP packaging since the pandemic began? Have they observed littering by SUP protective equipment?
- Do you have good examples of mitigation measures that your members put in place to reduce the impacts of SUP resulting from the response to COVID-19? Do you know if these measures are meant as short-term/temporary or long-term/permanent responses? *E.g. information campaigns, additional waste collection activities/infrastructure, new recycling possibilities*
- How do your members foresee trends in SUP in waste streams and littering during the next months of the pandemic? How are they preparing for this?
- Are you aware of data sources / reports, articles or other useful information sources that may help us understand how your members activities and waste treatment has been affected by COVID-19 with reference to SUP? *Please send links*

Interview questions for Municipal Waste Europe:

- Have your members seen changes in the type and volume of Single Use Plastics (SUP) that they receive in municipal waste since the beginning of the pandemic? (*both in separately collected plastics or mixed waste)*
- Have the volumes of SUP in household versus commercial waste changed? If so, how?
- Is SUP protective equipment found in separately collected plastic waste streams causing problems with respect to recycling technologies and markets? How and why (*difficult material composition of for example face masks, fear of contamination, etc.)*
- Have your members observed any changes in the prevalence and type of littering by SUP packaging since the pandemic began? Have they observed littering by SUP protective equipment?
- Do you have good examples of mitigation measures that your members put in place to reduce the impacts of SUP resulting from the response to COVID-19? Do you know if these measures are meant as short-term/temporary or long-term/permanent responses? *E.g. information campaigns, additional waste collection activities/infrastructure, new recycling possibilities*
- How do your members foresee trends in SUP in waste streams and littering during the next months of the pandemic? How are they preparing for this?
- Are you aware of data sources / reports, articles or other useful information sources that may help us understand how your members activities and waste treatment has been affected by COVID-19 with reference to SUP? *Please send links*

Interview questions for European Plastic Converters:

- Do you have data on European production and trade in SUP protective equipment (face masks, gloves) and single use medical equipment over and above that maintained by Eurostat?
- How quickly did the European industry respond to demands for SUP protective equipment in Europe and globally? Is Europe a key provider of (any of) these products in the global market?
- Do you have links to data-sources on the material composition of ‘typical’ SUP protective equipment (e.g. face masks and gloves)?

- Are these typical SUP protective equipment types recyclable or reusable? If not, could this be rectified (without having a negative impact on their protective function)? Do you have any good examples of companies that are producing recyclable or reusable protective equipment?
- Can you explain the fall in the European manufacture of plastic *packaging* during April to June 2020? Has this drop continued since then as far as you know?
- Have you observed any decrease in the demand for recycled plastics amongst European producers? If yes, why do you think that is? (E.g. drop in oil prices, fear of contamination, etc.)
- Do you have links to data-sources on the material composition of 'typical' SUP food packaging and utensils and shipment packaging for e-commerce?
- Do you know how big the role of bio-based plastic packaging is in these sectors?
- How does the industry foresee demand for, and production of SUP packaging and SUP protective equipment during the next months of the pandemic? How is the industry preparing for this?
- Have you seen any initiatives by your members to mitigate the impacts of higher SUP volumes during 2020? Do you know if these measures are meant as short-term/temporary or long-term/permanent responses? E.g. design for recycling
- Are you aware of other data sources / reports, articles or other useful information sources that might show changes in the production, trade and use of single use plastics as a result of the response to COVID-19? *Please send links*

Additional written information was received from:

- Naturvårdsverket (Swedish EPA)
- Ecommerce Europe
- DECO (Portuguese consumers association)
- Which? (UK consumer association)

Annex 2 – Detailed data on environmental and climate impacts

This section includes some more detailed data related to the assessment of environmental and climate impacts of single-use plastic products in section 3.

Table A2-1 – Environmental impacts of production, transport and waste management of single-use face masks imported to EU-27 from China between April and September 2020 from China

		AP	EP	FWAET	GWP	HTP	MAETP	ODP	POCP	TAETP
Unit		10^6 t SO_2 eq	10^6 t PO_4--- eq	10^6 t 1,4-DB eq	10^6 t CO2 eq	10^6 t 1,4-DB eq	10^6 t 1,4-DB eq	10^6 t CFC-11 eq	10^6 t C_2H_4 eq	10^6 t 1,4-DB eq
2020.03	Value	3,2	3,0	125	636	456	168890	3,5E-04	0,81	0,73
	BAU	4,1	3,9	159	811	582	215405	4,5E-04	1,03	0,93
	Difference	-0,9	-0,8	-34	-175	-126	-46515	-9,7E-05	-0,22	-0,20
2020.04	Value	8,4	8,1	330	1682	1207	446921	9,3E-04	2,14	1,94
	BAU	4,1	3,9	159	810	581	215261	4,5E-04	1,03	0,93
	Difference	4,4	4,2	171	872	625	231660	4,8E-04	1,11	1,01
2020.05	Value	12,2	11,6	476	2427	1741	644885	1,3E-03	3,08	2,80
	BAU	4,1	3,9	159	809	581	215117	4,5E-04	1,03	0,93
	Difference	8,1	7,7	317	1617	1160	429768	9,0E-04	2,05	1,86
2020.06	Value	8,7	8,3	340	1735	1245	461151	9,6E-04	2,20	2,00
	BAU	4,1	3,9	159	809	580	214973	4,5E-04	1,03	0,93
	Difference	4,6	4,4	182	926	665	246178	5,1E-04	1,18	1,07
2020.07	Value	7,7	7,4	302	1538	1103	408614	8,5E-04	1,95	1,77
	BAU	4,1	3,9	159	808	580	214829	4,5E-04	1,03	0,93
	Difference	3,7	3,5	143	729	523	193786	4,0E-04	0,93	0,84
2020.08	Value	7,2	6,9	281	1435	1029	381235	8,0E-04	1,82	1,65
	BAU	4,0	3,9	158	808	580	214685	4,5E-04	1,03	0,93
	Difference	3,1	3,0	123	627	450	166550	3,5E-04	0,80	0,72
2020.09	Value	8,7	8,4	342	1744	1251	463562	9,7E-04	2,21	2,01

		AP	EP	FWAET	GWP	HTP	MAETP	ODP	POCP	TAETP
	BAU	4,0	3,9	158	807	579	214541	4,5E-04	1,02	0,93
	Difference	4,7	4,5	184	937	672	249021	5,2E-04	1,19	1,08
Total 03/20 to 09/20	**Value**	**56,1**	**53,6**	**2196**	**11196**	**8032**	**2975257**	**6,2E-03**	**14,21**	**12,91**
	BAU	**28,4**	**27,1**	**1111**	**5662**	**4062**	**1504809**	**3,1E-03**	**7,19**	**6,53**
	Difference	**27,7**	**26,5**	**1085**	**5533**	**3970**	**1470448**	**3,1E-03**	**7,02**	**6,38**

Sources: Calculation by Oeko-Institut, PlanMiljø and IDEA Consult based on Allison et al. 2020 and ecoinvent 3.6 database

Table A2-2 – Environmental impacts of production, transport and waste management of gloves imported to EU-27 from China between April and September 2020 from China

		AP	EP	FWAET	GWP	HTP	MAETP	ODP	POCP	TAETP
Unit		10^6 t SO_2 eq	10^6 t PO_4-- eq	10^6 t 1,4-DB eq	10^6 t CO_2e	10^6 t 1,4-DB eq	10^6 t 1,4-DB eq	10^6 t CFC-11 eq	10^6 t C_2H_4 eq	10^6 t 1,4-DB eq
2020.03	Value	9.3	10.5	190	1 658	1 183	233 105	1.2E-03	2.81	2.24
	BAU	8.5	9.5	173	1 509	1 077	212 139	1.1E-03	2.56	2.04
	Difference	0.8	0.9	17	149	106	20 966	1.1E-04	0.25	0.20
2020.04	Value	11.5	13.0	235	2 053	1 465	288 612	1.5E-03	3.48	2.77
	BAU	8.4	9.4	171	1 496	1 067	210 334	1.1E-03	2.54	2.02
	Difference	3.1	3.5	64	557	397	78 278	4.0E-04	0.94	0.75
2020.05	Value	12.9	14.5	263	2 301	1 641	323 402	1.6E-03	3.90	3.11
	BAU	8.3	9.4	170	1 483	1 058	208 529	1.1E-03	2.52	2.00
	Difference	4.6	5.2	93	817	583	114 873	5.9E-04	1.39	1.10
2020.06	Value	15.1	17.0	308	2 697	1 924	379 058	1.9E-03	4.57	3.64
	BAU	8.2	9.3	168	1 471	1 049	206 724	1.1E-03	2.49	1.99
	Difference	6.9	7.7	140	1 226	875	172 335	8.8E-04	2.08	1.66
2020.07	Value	18.3	20.6	374	3 266	2 330	459 053	2.3E-03	5.54	4.41
	BAU	8.2	9.2	167	1 458	1 040	204 919	1.0E-03	2.47	1.97
	Difference	10.1	11.4	207	1 808	1 290	254 135	1.3E-03	3.07	2.44
2020.08	Value	16.5	18.5	336	2 935	2 094	412 537	2.1E-03	4.98	3.97
	BAU	8.1	9.1	165	1 445	1 031	203 114	1.0E-03	2.45	1.95
	Difference	8.4	9.4	170	1 490	1 063	209 423	1.1E-03	2.53	2.01
2020.09	Value	17.5	19.7	356	3 114	2 222	437 809	2.2E-03	5.28	4.21
	BAU	8.0	9.0	164	1 432	1 022	201 309	1.0E-03	2.43	1.94
	Difference	9.4	10.6	192	1 682	1 200	236 501	1.2E-03	2.85	2.27
Total 03/20 to 09/20	**Value**	**101.1**	**113.8**	**2 062**	**18 023**	**12 858**	**2 533 577**	**1.3E-02**	**30.57**	**24.36**
	BAU	**57.7**	**65.0**	**1 178**	**10 294**	**7 344**	**1 447 066**	**7.4E-03**	**17.46**	**13.91**
	Difference	**43.3**	**48.8**	**884**	**7 729**	**5 514**	**1 086 511**	**5.5E-03**	**13.11**	**10.45**

Sources: Calculation by Oeko-Institut, PlanMiljø and IDEA Consult based on Eurostat datasets sts_inpr_m and DS-066341 and ecoinvent 3.6 database

Table A2-3 – Environmental impacts of plastic packaging production incl. end-of-life waste management in EU-27$_{2020}$ between March and October 2020

		AP	EP	FWAET	GWP	HTP	MAETP	ODP	POCP	TAETP
Unit		10^6 t SO_2 eq	10^6 t PO_4--- eq	10^6 t 1,4-DB eq	10^6 t CO_2e	10^6 t 1,4-DB eq	10^6 t 1,4-DB eq	10^6 t CFC-11 eq	10^6 t C_2H_4 eq	10^6 t 1,4-DB eq
2020.03	Value	9.6E-03	2.6E-03	7.9	4.9	3.3	13 034	9.5E-08	4.4E-04	3.2E-03
	BAU	9.5E-03	2.6E-03	7.8	4.9	3.3	12 926	9.5E-08	4.4E-04	3.1E-03
	Difference	8.0E-05	2.1E-05	0.1	0.0	0.0	108	7.9E-10	3.7E-06	2.6E-05
2020.04	Value	9.3E-03	2.5E-03	7.6	4.8	3.2	12 594	9.2E-08	4.3E-04	3.1E-03
	BAU	9.5E-03	2.6E-03	7.8	4.9	3.3	12 904	9.4E-08	4.4E-04	3.1E-03
	Difference	-2.3E-04	-6.2E-05	-0.2	-0.1	-0.1	-310	-2.3E-09	-1.0E-05	-7.6E-05
2020.05	Value	9.1E-03	2.5E-03	7.5	4.7	3.2	12 422	9.1E-08	4.2E-04	3.0E-03
	BAU	9.5E-03	2.6E-03	7.8	4.9	3.3	12 882	9.4E-08	4.4E-04	3.1E-03
	Difference	-3.4E-04	-9.1E-05	-0.3	-0.2	-0.1	-459	-3.4E-09	-1.6E-05	-1.1E-04
2020.06	Value	9.1E-03	2.4E-03	7.4	4.6	3.1	12 300	9.0E-08	4.2E-04	3.0E-03
	BAU	9.5E-03	2.6E-03	7.8	4.9	3.3	12 859	9.4E-08	4.4E-04	3.1E-03
	Difference	-4.1E-04	-1.1E-04	-0.3	-0.2	-0.1	-560	-4.1E-09	-1.9E-05	-1.4E-04
2020.07	Value	9.1E-03	2.5E-03	7.5	4.7	3.1	12 398	9.1E-08	4.2E-04	3.0E-03
	BAU	9.5E-03	2.6E-03	7.7	4.8	3.3	12 837	9.4E-08	4.3E-04	3.1E-03
	Difference	-3.2E-04	-8.7E-05	-0.3	-0.2	-0.1	-439	-3.2E-09	-1.5E-05	-1.1E-04
2020.08	Value	9.3E-03	2.5E-03	7.6	4.8	3.2	12 581	9.2E-08	4.3E-04	3.1E-03
	BAU	9.4E-03	2.5E-03	7.7	4.8	3.3	12 815	9.4E-08	4.3E-04	3.1E-03
	Difference	-1.7E-04	-4.6E-05	-0.1	-0.1	-0.1	-234	-1.7E-09	-7.9E-06	-5.7E-05
2020.09	Value	9.4E-03	2.5E-03	7.7	4.8	3.2	12 765	9.3E-08	4.3E-04	3.1E-03
	BAU	9.4E-03	2.5E-03	7.7	4.8	3.2	12 793	9.4E-08	4.3E-04	3.1E-03
	Difference	-2.1E-05	-5.6E-06	0.0	0.0	0.0	-28	-2.0E-10	-9.5E-07	-6.8E-06
2020.10	Value	9.4E-03	2.5E-03	7.7	4.8	3.2	12 789	9.4E-08	4.3E-04	3.1E-03
	BAU	9.4E-03	2.5E-03	7.7	4.8	3.2	12 771	9.3E-08	4.3E-04	3.1E-03
	Difference	1.4E-05	3.7E-06	0.0	0.0	0.0	19	1.4E-10	6.3E-07	4.6E-06

		AP	EP	FWAET	GWP	HTP	MAETP	ODP	POCP	TAETP
Total 03/20 to 10/20	**Value**	**7.4E-02**	**2.0E-02**	**60.8**	**38.1**	**25.6**	**10 0883**	**7.4E-07**	**3.4E-03**	**2.5E-02**
	BAU	**7.6E-02**	**2.0E-02**	**62.0**	**38.8**	**26.1**	**102 787**	**7.5E-07**	**3.5E-03**	**2.5E-02**
	Difference	**-1.4E-03**	**-3.8E-04**	**-1.1**	**-0.719**	**-0.5**	**-1 904**	**-1.4E-08**	**-6.4E-05**	**-4.6E-04**

Sources: Calculation by Oeko-Institut, PlanMiljø and IDEA Consult based on Allison et al. 2020 and ecoinvent 3.6 database

Table A2-4 – Global warming potential (GWP) for manufacturing, transport and waste management of cups, lids and stirrers

GWP [kg CO_2e/unit]	Production	Transports	Waste management
Cups SUP	0.0253	0.0015	0.0166
Lids SUP	0.0113	0.0004	0.0081
Stirrers SUP	0.0013	0.0001	0.0015

Sources: Calculation by Oeko-Institut, PlanMiljø and IDEA Consult based on Eunomia (2018) and ecoinvent 3.6 database

Table A2-5 – Global warming potential (GWP) for manufacturing, transport and waste management of food containers and cutlery of delivery and take-away food services

GWP [kg CO_2e/unit]	Production	Transports	Waste management
Food containers	0.0753	0.0027	0.0573
Cutlery	0.0055	0.0004	0.0066

Sources: Calculation by Oeko-Institut, PlanMiljø and IDEA Consult based on Eunomia (2018) and ecoinvent 3.6 database

Table A2-6 – Weights and material share of typical take-away food packaging products

Product / Component	Typical weight [g]
polyethylene, low density (LDPE)	4.45
polyethylene, high density (HDPE)	2.61
polypropylene (PP)	3.37
polyethylene terephthalate (PET)	2.9
polystyrene (PS)	0.53
expanded polystyrene (EPS)	0.22
Other plastics	0.31

Sources: Combination of data from PlasticEurope 2020 (page 27) and Eurostat: [env-waspac]

Table A2-7– Global warming potential (GWP) for manufacturing, transport (500 kilometres by lorry) and waste management of several plastic types used for packaging in online sales and e-commerce

GWP [kg CO_2e/kg]	Production	Transports	Waste management
LDPE	2.3	0.7	1.0
HDPE	2.1	0.7	1.0
PP	2.1	0.7	0.7
PET	3.2	0.7	0.9
PS	3.8	0.7	1.1
EPS	3.6	0.7	1.1

Sources: Calculation by Oeko-Institut, PlanMiljø and IDEA Consult based on ecoinvent 3.6 database

Table A2-7 – GWP for the production of plastic products

Product	GWP [kg CO_2e/kg product]
polystyrene, high impact	3.74
polystyrene, general purpose	3.76
polystyrene, extruded	9.68
polystyrene, expandable	3.64
polyethylene terephthalate, granulate, amorphous	3.18
polyethylene terephthalate, granulate, bottle grade	3.42
polypropylene, granulate	2.12
polyethylene, high density, granulate	2.09
polyethylene, low density, granulate	2.27
Polyetherimide	119.58
polyurethane, flexible foam	5.35
polyurethane, rigide foam	5.87

Source: ecoinvent 3.6, GaBi 10

Table A2-8– GWP for the production of plastic manufacturing

Process	GWP [kg CO_2e/kg product]
extrusion, plastic film	0.42
stretch blow moulding	1.17
packaging film, low density polyethylene	2.75
injection moulding	1.00
extrusion of plastic sheets and thermoforming, inline	0.18
calendering, rigid sheets	0.33
blow moulding	0.93

Source: ecoinvent 3.6, GaBi 10

Annex 3 – Online webinar participants

Workshop n°1 on 9th December 2020

In a first workshop, representatives of the EEA countries were invited to present their experiences, challenges and good practice examples related to single-use plastics and environmental impacts from COVID-19.

Main topics of the workshop:

- Which current trends in consumption (including in consumer behaviour/perceptions), production and trade of single-use plastics and environmental impacts from COVID-19 are you aware of in your country? How do you expect these trends progressing over the next year(s)?

- Which environmental impacts do you observe in your country due to consumption of single-use plastics from COVID-19? Are there any new or additional challenges for the collection and management of single-use plastic waste from COVID-19?

- Are you aware of any best practice initiatives in your country to reduce the impacts or increase the circularity of single-use plastic medical equipment, food packaging and internet sales packaging from COVID-19?

	Participant‘s name	Country
1	Pohl Denis	Belgium
2	Mira Zovko	Hungary
3	Dagny Kungus	Estonia
4	Anne-France Rihoux	Belguim
5	Mihkel Krusberg	Estonia
6	Stella Sluciakova	Slovakia
7	Lore Claes	Belgium
8	Ivana Stojanovic	Montenegro
9	Pavel Ruzicka	Czech Republic
10	Pablo Rodriguez Porras	Spain
11	Saskia Manshoven	Belgium
12	Catarina Ribeiro	Portual
13	Ana Brandao	Portual
14	Mustafa Aydin	EEA
15	Adriana Gheorghe	EEA
16	Eva Gelabert	EEA
17	Anja Van Campenhout	Belgium
18	Małgorzata Grodzińska-Jurczak	Poland
19	Stefanie Werner	Germany
20	Jurgita Užkurnienė	Lithuania
21	Dalia Stakvilevičiūtė	Lithuania
22	Jasna Kufrin	Croatia
23	Ieva Kazulytė	Lithuania
24	Baskutienė Jolanta	Lithuania
25	Chrystel Scribe	France

26	Francesca Montevecchi	Austria
27	Lena Stig	Sweden
28	Grimminger, Sonia	Germany
29	Carmela Carscone	Italia
30	Nikola Karanovic	Serbia
31	Alonso Bomba Maria	Malta
32	Ida Tange	EEA
33	Lars Mortensen	EEA
34	Kathrin Graulich	OEKO
35	Clara Löw	OEKO
36	David Watson	PlanMiljø
37	Jürgen Sutter	OEKO
38	Georg Mehlhart	PlanMiljø
39	Valentijn Bilsen	IDEA Consult
40	Federico Bley	IDEA Consult

Workshop n°2 on 13th January 2021

In the second workshop, overall outcomes of the study were presented and discussed.

	Participant's name	Country
1	Alyssa Di Cara	Luxembourg
2	Ana Nistorescu	Romania
3	Anabela Santiago	Portugal
4	Anna Baczyk	Poland
5	Arta Kodra	Albania
6	Attard Bason Marie Claire (at ERA)	Malta
7	Carlo Piscitello	Italy
8	Carolina Gouveia	Portugal
9	Casper Mayland	Denmark
10	Chrystel Scribe	France
11	Ecaterina Gildau	Romania
12	Egzona Shala	Republic of Kosovo
13	Elisabet Kock	Sweden
14	Ērika Lagzdiņa	Latvia
15	Eva Gelabert	EEA
16	Fatma Nur Cebecioğlu	Turkey
17	Fieder Ildikó	Hungary
18	Fiona McCoole	Ireland
19	Günther, Jens	Germany
20	Ifka Vivien	Hungary
21	Inês Mateus	Portugal
22	Ivana Jasikova	Slovakia
23	Ivana Novikmecova	Slovakia
24	Jasna Kufrin	Croatia
25	Jean-Paul Lickes	Luxembourg
26	Jil Schmitz	Luxembourg

	Participant's name	Country
27	Johan Lindh	Sweden
28	Johanna Eriksson	Sweden
29	Julia Taylor	Sweden
30	Jurgita Užkurnienė	Lithuania
31	Katarina Koskova	Slovakia
32	Lena Stig	Sweden
33	Lore Claes	Belgium
34	Mafalda Mota	Portugal
35	Malgorzata Bednarek	Poland
36	Mihkel Krusberg	Estonia
37	Nadine Bertrand	Luxembourg
38	Natalia Georgiou	Cyprus
39	Niamh Rogan	Ireland
40	Paolo Marengo	
41	Pernille Cuisy Svensson	Denmark
42	Petra Urbanova	Czech Republic
43	Pohl Denis	Belgium
44	Rana Pant	Belgium
45	Rasmus Eisted	Denmark
46	Rodrigo Gonçalves	Portugal
47	Rudīte Vesere	Latvia
48	Sarah Risch	Belgium
49	Şeyma UÇAR SEÇGEL	Turkey
50	Sílvia Ricardo	Portugal
51	Simona Ghita	Romania
52	Sivadó Brigitta	Hungary
53	Slučiaková Stella	Slovakia
55	Špalková Viera	Slovakia
56	Tanya Vladimirova	Bulgaria
57	Tara Higgins	Ireland
58	Tarja Riitta	Finland
59	Tatiana Gustafikova	Slovakia
60	Valentínyi Nóra	Hungary
61	Vanya Veras	
62	Ya. Dragotinov	Bulgaria
63	Ida Tange	EEA
64	Lars Mortensen	EEA
65	Kathrin Graulich	OEKO
66	Clara Löw	OEKO
67	David Watson	PlanMiljø
68	Jürgen Sutter	OEKO
69	Georg Mehlhart	PlanMiljø
70	Valentijn Bilsen	IDEA Consult
71	Federico Bley	IDEA Consult

European Topic Centre on Waste and Materials
in a Green Economy
Boeretang 200
BE-2400 Mol
Tel.: +14 33 59 83
Web: wmge.eionet.europa.eu
Email: etcwmge@vito.be

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