WP T2 INNOVATION ON TEXTILE WASTE MANAGEMENT

ACTIVITY A.T2.

Deliverable: Economic evaluation

Additional ENTeR pilot case: Textile waste coming from medical devices concerning COVID-19 emergency

Version 1

10/2020

Responsible partner:

PP2 UNIVA - IT

CONTENT

This document has been issued within the project ENTeR (CE 1136) thanks to the funding received from the European Union under the Interreg Central Europe Programme (2nd call 2016)

1. Scope

This report presents the economic scenario by pandemic waste production. These wastes are identified within the category 18 00 00 of ECW codes.

The current pandemic situation has generated an increase in medical waste such as surgical and respiratory masks due to use not only in the health sector but also by the whole population in order to protect themselves from potential infections.

Currently, after use disposable textile medical devices coming from hospitals and similar structures are mostly destined to destruction, while those used by citizens are collected with urban waste. In both options there is not a material recovery through recycle or reuse. Implementing new waste management, in particular for waste coming from citizens use, it would be possible to recover materials for new productions with consequent potential economic benefits. To evaluate these benefits, economic impacts related to new material generation and product manufacture will be studied. Then, on the basis of proposed new waste management procedures, costs related to collection, logistic, sanitation/chemical removal and recycle of medical textile waste will be evaluated. Comparative study between current and proposed waste management practices will be performed to verify if there are significant economic benefits.

2. New waste production on pandemic scenario

2.1. General overview

As European governments seek to open their economies after months of lockdowns, national authorities broadly acknowledge that masks or other face coverings can help limit the spread of the coronavirus.

Here is an overview of regulations in place in the regions' largest economies (July 2020):

GERMANY - The rules are set state by state, but coverings are mandatory in shops and public transportation nationwide. In some states there are fines for not wearing them, in others not.

FRANCE - Mask-wearing is now compulsory in all enclosed spaces after a resurgence of cases. Some towns with lots of tourists have also opted to make masks mandatory in the busiest areas outdoors.

ITALY - Masks are always mandatory in closed public spaces, including on public transport, and whenever it is impossible to maintain social distancing outdoors. Regions can impose stricter rules if necessary.

POLAND - People must wear masks in public indoor spaces if they are unable to maintain a distance of at least 2 meters from others.

These rules are time changing due to possible COVID -19 resurgence as it is more and more evident by the end of August in many European Countries.

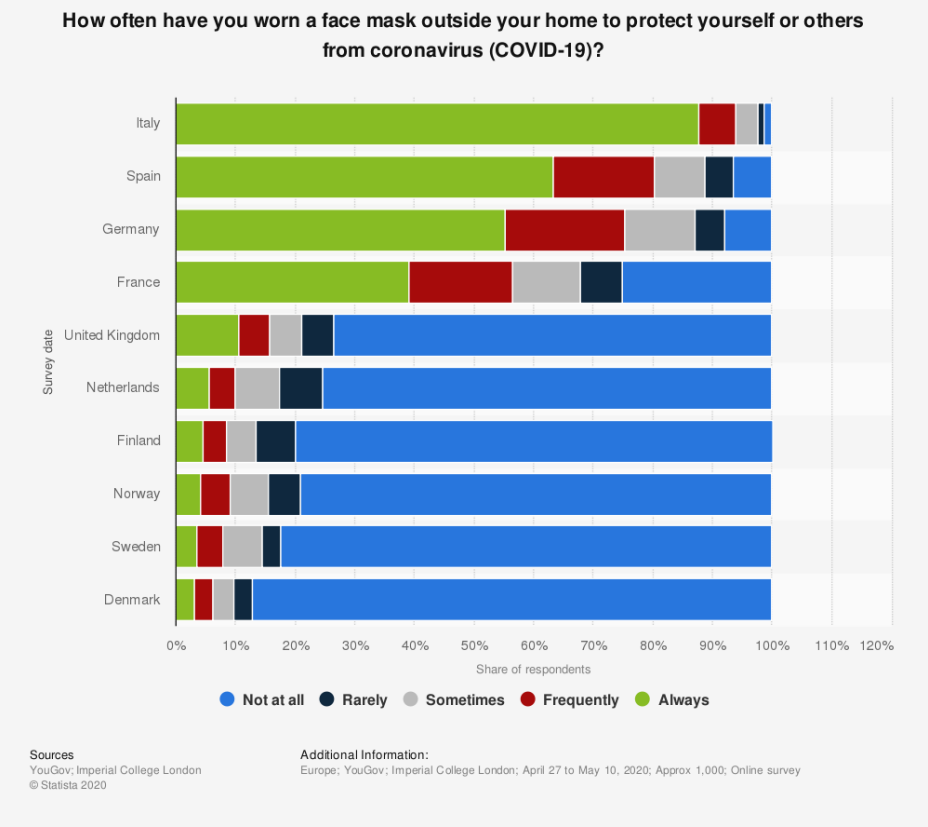
Due to COVID-19, face masks are in high demand across the globe. Over 50 countries have made mask-wearing in public mandatory. China still makes most masks, but new makers are entering the market. The humble face mask has become sought after across the globe.

Supplies of masks have run low as coronavirus has spread, and fashion houses[1] and carmakers[2] are among the companies that have started making them to protect health of workers and others as restrictions begin to ease in many places.

Many governments are making the wearing of masks a precondition for lifting lockdowns, allowing people to return to shops, offices and factories. And with any potential vaccine many months away, billions more masks are going to be needed.

As a result, prices are soaring. Basic surgical masks that until last year cost a few cents are now retailing at as much as $1.25 each[3] in some places and prices of respirator-grade N95 masks, which stop at least 95% of particles, have been reported as high as $25.

An interview by Imperial College, London, reported percentage of face mask use in main European countries, see figure below.



The World Health Organization[4] says if you are healthy, you only need to wear a mask if you are taking care of a person with COVID-19. The WHO also advises people to wear one if they are coughing and sneezing, and says they are only effective if combined with frequent handwashing.

[1] https://metro.co.uk/2020/03/30/burberry-making-gowns-masks-nhs-12479187

[2] https://uk.reuters.com/article/uk-health-coronavirus-bmw/bmw-to-start-producing-face-masks-idUKKBN21Q0ZZ

[3] https://www.telegraph.co.uk/money/consumer-affairs/best-face-masks-buy-coronavirus-cost/

[4] https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/when-and-how-to-use-masks

Official advice varies from country to country. The UK government, for example, advises wearing a face covering in enclosed spaces where social distancing is not possible, like on public transport.[5]

The United States Centers for Disease Control and Prevention (CDC), similarly, recommends wearing masks in places where social distancing is not possible, such as shops, to slow the spread of the virus.[6] Like the UK, it advocates simple cloth face coverings and says surgical masks should be reserved for health workers.

More than 50 countries are reported to have made it compulsory to wear a face mask in public places, including Venezuela and Vietnam, which were among the first to act. The Czech Republic was the first European nation to mandate masks, on 18th March.[7]

Some airlines, including American, Lufthansa, and United, have announced that face masks will be compulsory in terminals as well on flights. Eurostar, which operates train services between England and France, also requires passengers to wear masks. Many countries impose fines for failing wearing masks and some are distributing them free. In France, for example, failure to wear a mask on public transport can incur a fine of up to 150 €. In Italy, last DPCM of October introduces fines up to 1.000 €.[8]

[5] https://www.gov.uk/government/publications/coronavirus-covid-19-meeting-with-others-safely-social-distancing#face-coverings

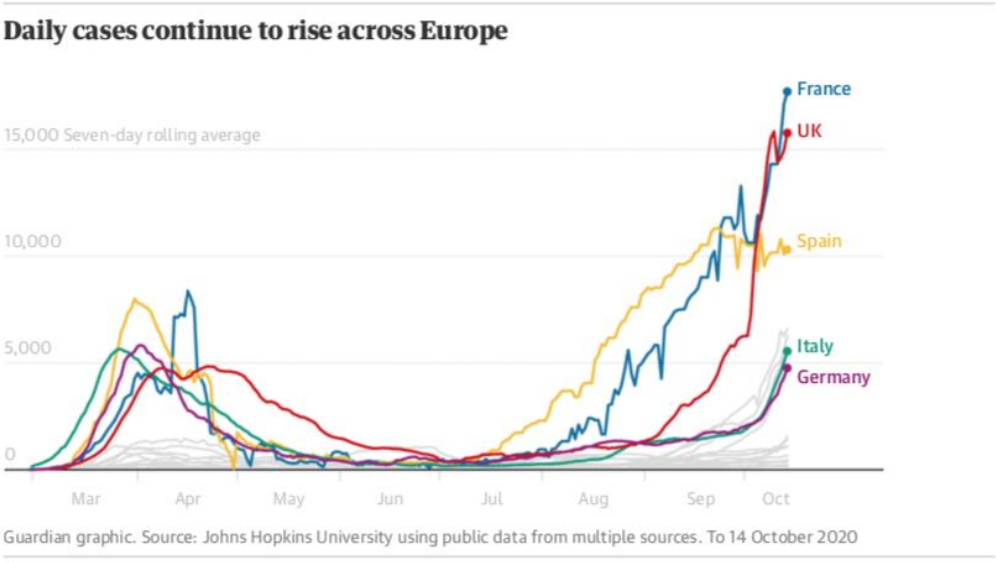
[6] https://www.cdc.gov/coronavirus/2019-ncov/

[7] https://www.aljazeera.com/news/2020/08/17/which-countries-have-made-wearing-face-masks-compulsory/

[8] http://www.salute.gov.it/

2.2. Europe and Countries scenario

COVID 19 is spreading around the world, causing deaths and major disruption to the global economy. In Europe, see figure below, a second phase of epidemic growth is started after the summer.



Manufacturers across the world are producing three types of mask – surgical masks, respirators and cloth face coverings.

Surgical masks are designed to protect patients from infection during surgery, for example if a doctor coughs in an operating theatre. Respirators, on the other hand, filter air passing in and out of the mask.

Cloth face coverings, including home-made masks, are recommended by the CDC as they help stop the wearer from spreading infection. But COVID-19 is spread by micro-droplets emitted when breathing which can enter the body through the eyes and mouth.

To combat micro-droplets, health workers wear visors for eye protection. The WHO says the best way to avoid infection is to wash hands frequently and avoid touching your face. A mask may help you stop spreading the virus, but hygiene is the key to avoid getting it, it says.[9]

In European Countries, a different approach has been established to block COVID-19 transmission, and consequently, different results in this strong world battle again epidemic. Below a short description of rules in some Countries.

Belgium

Shops must shut at 10pm, **cafés** 11pm, **restaurants** 1am. Maximum 10 people at a table in a restaurant, four people at a table in cafés. No more than four people (except the under-12s and those living under the same roof) may **gather** together, either at home or in public spaces. Each person should limit contact with others of more than 15 minutes to a maximum of three people per month. For public events, no more than 200 people inside and 400 outside. No festivals, no discos, but all other sport and cultural venues open. Home working where possible.

[9] https://www.weforum.org/agenda/2020/05/coronavirus-face-masks-rules-supply/

Czech Republic

The country has the worst infection record in Europe, after touting its success in spring as one of the first countries to introduce mask-wearing. A state of emergency was introduced on 5th October, followed by an escalating series of restrictions. **Masks** are mandatory in indoor public spaces including public transport, as well as at outdoor tram and bus stops, platforms and waiting rooms. **Pubs and restaurants** shut from 14th October and are restricted to selling on a takeaway basis from dispensing windows, and only until 8pm. **Gatherings** of more than six people outside or indoors are prohibited, organized or otherwise, with only precisely specified exceptions. All **schools** except kindergartens have switched to distance learning, with pupils in the second stage of primary school being divided into half-classes for the next two weeks.

France

Masks are mandatory outdoors and in shops, restaurants and indoor public spaces in all areas where the virus is spreading rapidly. A **curfew** comes into force in the Paris region and eight other cities deemed on "maximum alert" from midnight on Saturday. The curfew from 9pm to 6am will be imposed for at least four weeks but could be extended until 1st December. **Bars** are already shut in areas of "maximum alert", while **restaurants** will remain open, but only until 9pm. Customers must leave contact details and there can be no more than six people at a table. Events of more than 1,000 people are banned in high-risk areas, as well as **gatherings** of more than 10 people in public places, parks and gardens. A maximum of six people are advised at private gatherings at home. University lecture halls, canteens and classrooms must operate at 50% capacity; home working where possible 2-3 days a week.

Germany

The heads of Germany's 16 federal states agreed on new uniform restrictions to contain outbreaks in coronavirus hotspots: in cities and regions seeing more than 35 infections per 100,000 people over the space of 75 days, **masks** will be mandatory in public gathering places. Where the seven-day infection rate rises above 50 cases per 100,000 people, private **gatherings** will be limited to a maximum of 10 participants or the members of two households, and **bars and restaurants** ordered to close at 11pm.

Hungary

The country is experiencing a second wave with much higher daily case numbers than the first. The government is determined to avoid a full lockdown, but since 1st September has closed its borders to almost all visitors. **Masks** are mandatory in most indoor public places, with fines recently introduced for non-compliance. **Bars and restaurants** must shut by 11pm. **Gatherings** are allowed, but capped at 500 people. **Schools** are open with temperature checks for pupils from 1st October. Some individual schools with Covid outbreaks have closed.

Italy

Masks are compulsory outside across Italy as well as in enclosed spaces such as shops, bars, museums, airports and all forms of public transport. **Bars and restaurants** must close at midnight. Tables have to be sanitized after each customer's leave and must be at least 1 metre apart. People are strongly advised to host **gatherings** of no more than six people inside their homes and to wear masks at home if it is difficult to maintain a safe distance with others. **Schools** reopened across the country in September. Teachers and pupils over the age of six must wear masks except when sitting at desks, as long as physical distancing is maintained. Temperatures are taken on arrival.

Poland

Poland relaxed most measures in summer. After seeing daily cases in the hundreds throughout the first wave, in the past two months case numbers have soared and restrictions are

returning. **Masks** are mandatory indoors and on public transport, and starting from mid-October they will again be mandatory in public outdoor places as well. **Bars and restaurants** are open with no restrictions on hours. **Gatherings** are allowed, but physical distancing rules are in place for indoor buildings such as theatres. **Schools** are following a hybrid in-person/online system and mostly remain open for now.

Slovakia

One of Europe's champions in terms of low numbers in spring, Slovakia has further toughened existing restrictions from 15th October. **Masks** are mandatory outdoors when in city or town centres or on the streets, but not obligatory in forests or natural environments. **Bars, restaurants and cafés** are banned from serving indoors and limited to takeaway and outdoor seating facilities. Large **gatherings** are cancelled except weddings, baptisms and funerals. Top sporting competitions are allowed, but must take place without an audience and only after participants have tested negative. Secondary **schools** are closed and restricted to distance learning. Primary school pupils are required to wear masks in class.

Spain

Four months after its strict 13-week lockdown was lifted, Spain has become the worst-affected country in western Europe, with Madrid its worst-hit region. **Masks** are compulsory in outdoor and enclosed spaces across the country. The city of Madrid and eight satellite towns are in a limited **lockdown**, with people allowed to enter or exit the affected areas only on work, school or medical grounds or for other pressing reasons. Public and private **gatherings** are limited to six people, and bars and restaurants must operate at 50% of their interior capacity and close by 11pm. From 15th October, **bars and restaurants** in Catalonia will be limited to offering delivery or takeaway services. Shops and markets will operate at 30% capacity, and gyms, cinemas and theatres at 50%, and children's play areas will close at 8pm. The regional government of Navarra has ordered all bars and restaurants to reduce their capacity to 30% and to close at 10pm. It has also said that no more than six people should meet.

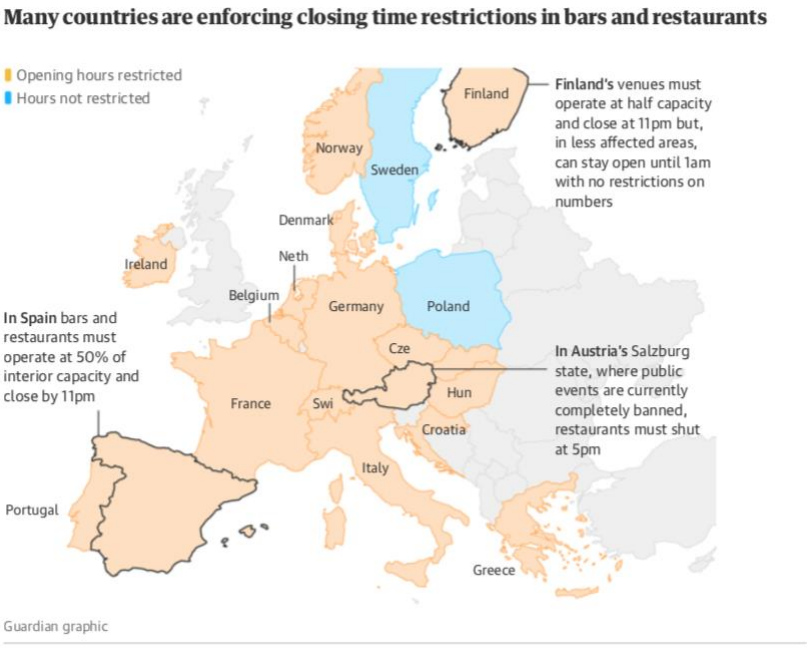
Sweden

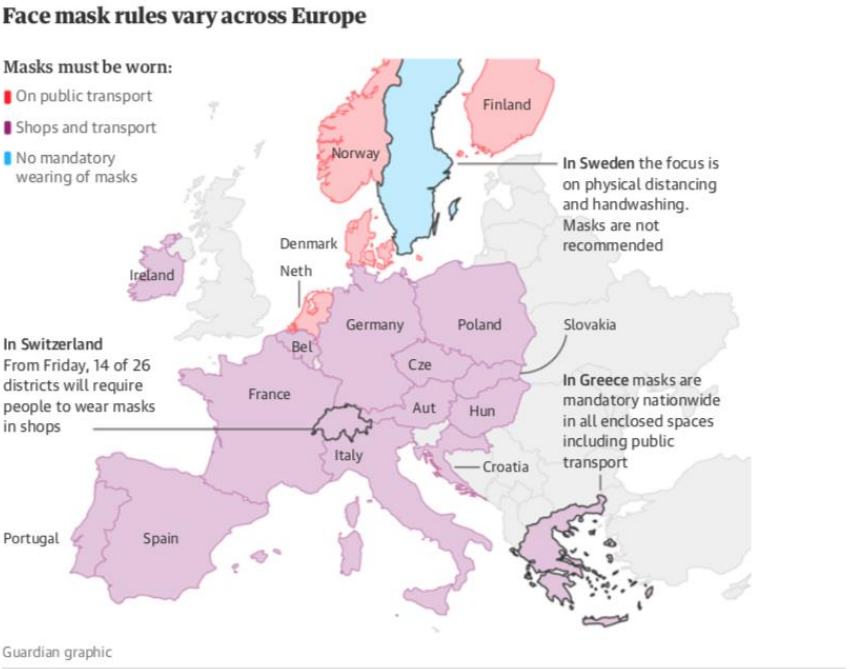
New rules will come into effect on 19th October allowing regional authorities to introduce their own local guidelines. These may include recommendations to avoid public transport, unnecessary travel, visiting people in a risk group, and going to shopping centers, gyms and pools. **Masks** are not recommended. National rules require customers in **bars and restaurants** to be seated, with groups separated by at least 1 meter, and **gatherings** of more than 50 are banned. People have been urged to work from home if they can, stay at home if they have symptoms, wash their hands, respect physical distancing, avoid large social gatherings, and use means of travel other than public transport if possible. People in **high-risk groups** or aged over 70 are still expected to avoid shops, restaurants and public transport and if possible to have their food or medicines delivered.

Switzerland

Fourteen of Switzerland's 26 cantonal authorities requires people to wear **masks** while shopping and limiting opening times for **bars and restaurants**. The Swiss government relaxed restrictions on 1st October to allow cultural and sports events with more than 1,000 visitors.

Below two pictures that show different mask and public regulations in Europe.





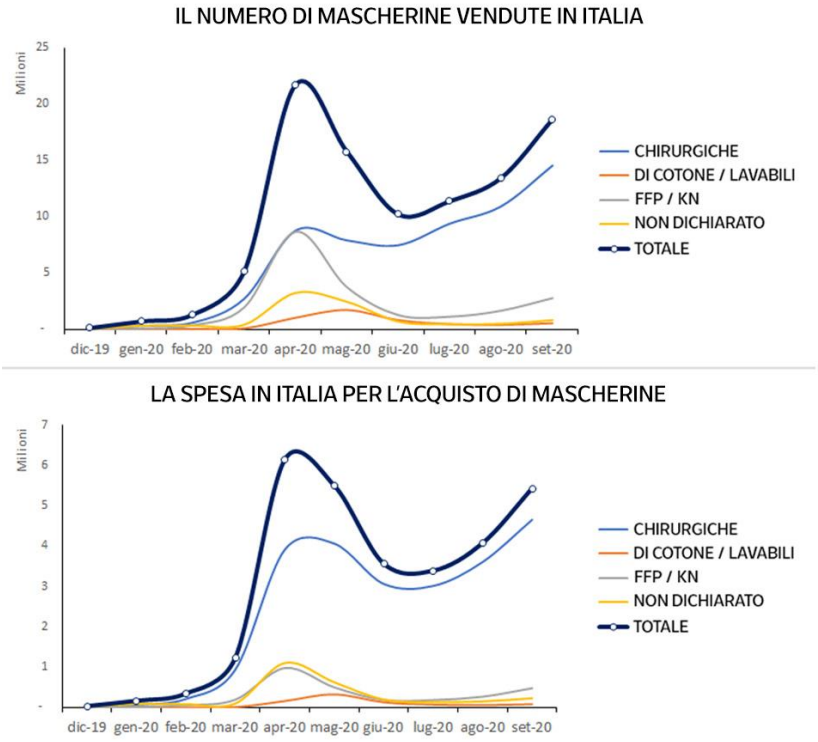
2.2.1. Italy

In Italy, during first round of COVID pandemic, from March to April, some analysis has been done on mask amount necessary for medical purpose and citizens protection.

Francesco Saverio Violante, professor of the Alma Mater and director of Occupational Medicine at the Policlinico Sant'Orsola in Bologna, underlines that it must be considered that a surgical mask weighs in a range between 5 and 12 grams, we do 8-9 on average: then multiplying by 40 million the masks used in one day of highest COVID crisis, we get up to 300 tons of waste that are produced

in a day. Considering that non-woven fabric is made of polypropylene or other plastics of this nature, these hundreds of tons of waste need to be disposed of.[10]

In the following picture, sorry for Italian language, the trend of selling mask of different type (surgical, FFP2, citizen mask by cotton and washing, etc..) both in volume and money is shown. Actually, a fast growth is foreseen due to new second COVID pandemic wave.[11]



From Government source[12], around 600 Millions of masks for adults and children have been distributed by Government to schools. These incredible numbers confirm the large amount of waste. If we assume a week frequency for mask changing by around 40 millions of Italian people and a compulsory use in open and close spaces for around 26 weeks (half of one year), we need around 1 billion of masks. According to medium weight of 8 grams/mask, 8,000 tons of waste by mask could be expected this year as a conservative value.

If we check all waste production with EWC 18.00.00 descriptor, in EUROSTAT EWC C.18 and EWC and C.17 are together, we have 38,624 tons (plastic) plus 784 tons (textile) in 2018, last data available, and 404,634 tons (chemicals and medical waste) in 2016, last data available.[13] This dataset contains also materials to produce mask, gloves, etc., … If we sum all of these, the waste production due to pandemical situation can be summarized to impact around 2% but in reality the

[10]https://www.ilfattoquotidiano.it/2020/05/21/covid-verso-450mila-tonnellate-di-guanti-e-mascherine-da-smaltire-ecomafie-troppe-deroghe-costa-ridurre-lusa-e-getta/5804636/

[11] Corriere della Sera Federico Fubini 16 October 2020

[12] http://www.governo.it/it/dipartimenti/commissario-straordinario-lemergenza-covid-19/cscovid19-mschgel/15243

[13] https://ec.europa.eu/eurostat/databrowser/view/ENV_WASGEN__custom_127289/default/table?lang=en

impact is higher because other waste, EWC 17 and medical, creates a higher volume in this dataset.

2.2.2. Czech Republic

A similar analysis as that done for Italy is performed with EUROSTAT data related to Czech Republic.

If we check all waste production with EWC 18.00.00 descriptor, in EUROSTAT EWC C.18 and EWC and C.17 are together, we have 7,709 tons (plastic) plus 1,909 tons (textile) in 2018, last data available, and 59,208 tons (chemicals and medical waste) in 2016, last data available.[14] This dataset contains also materials to produce mask, gloves, etc., …

2.2.3. Germany

A similar analysis as that done for Italy is performed with EUROSTAT data related to Germany.

If we check all waste production with EWC 18.00.00 descriptor, in EUROSTAT EWC C.18 and EWC and C.17 are together, we have 71,985 tons (plastic) plus 1,577 tons (textile) in 2018, last data available, and 797,706 tons (chemicals and medical waste) in 2016, last data available. This dataset contains also materials to produce mask, gloves, etc., …

2.2.4. Hungary

A similar analysis as that done for Italy is performed with EUROSTAT data related to Hungary.

If we check all waste production with EWC 18.00.00 descriptor, in EUROSTAT EWC 18 and EWC 17 are together, we have 15,878 tons (plastic) plus 0 tons (textile) in 2018, last data available and 13,855 tons (chemicals and medical waste) in 2016, last data available. This dataset contains also materials to produce mask, gloves, etc., …

2.2.5. Poland

A similar analysis as that done for Italy is performed with EUROSTAT data related to Poland.

If we check all waste production with EWC 18.00.00 descriptor, in EUROSTAT EWC C.18 and EWC and C.17 are together, we have 23,800 tons (plastic) plus 3,925 tons (textile) in 2018, last data available, and 116,250 tons (chemicals and medical waste) in 2016, last data available. This dataset contains also materials to produce mask, gloves, etc., …

[14] https://ec.europa.eu/eurostat/databrowser/view/ENV_WASGEN__custom_127289/default/table?lang=en

3. Main players and manufacturers

In the pandemic situation caused by COVID-19, there is an increment of medical single-use personal protection equipment and consequently an increment of the medical waste not only deriving from hospitals and clinics but also from the population with a mass use to prevent the spread of the virus.

World Health Organization (WHO) has so far shipped nearly half a million sets of personal protective equipment to 47 countries, but supplies are rapidly depleting.

Based on WHO modelling, an estimated 89 million medical masks are required for the COVID-19 response each month. For examination gloves, that figure goes up to 76 million, while international demand for goggles stands at 1.6 million per month.[15]

Recent WHO guidance calls for the rational and appropriate use of PPE in healthcare settings, and the effective management of supply chains.

WHO is working with governments, industry and the Pandemic Supply Chain Network to boost production and secure allocations for critically affected and at-risk countries.

To meet rising global demand, WHO estimates that industry must increase manufacturing by 40 per cent.

These values could be underestimated. The Minnesota conglomerate 3M is one of the world's largest manufacturers of N95 filtering face masks, which have been in high demand in the U.S. and around the world since the coronavirus outbreak. N95 respirators are so named because they are capable of filtering out 95% of large and small particles, including certain types of bacteria. They are considered essential equipment in occupations ranging from construction to medicine.

And in early 2020 health officials worried there were not nearly enough of them. In early March, officials from the U.S. Department of Health and Human Services said the country had only about 35 million of the **3.5 billion** N95 respirators needed in the event of a full-blown pandemic.

3M doubled global production to 1.1 billion per year from about 400 million per year, and the company said in late March it plans to double production again to 2 billion within 12 months.[16]

In February, China's daily production of all types of masks soared from around 10 million to 115 million by the end of that month, and production has expanded 12-fold since the pandemic started.

Supplies of masks have been disrupted by countries banning exports or requisitioning supplies within their borders and shortages of specialist fabrics used to make the more advanced types of respirator masks.

The disposable face masks industry houses both international and domestic market players. Prominent market participants compete on the basis of price and product quality. Small and medium-sized market players are expected to show considerable improvements in the foreseeable future, given the moderate level of capital expenditure needed to set up a business. The large-sized companies, however, are likely to aim for global expansion, in a bid to gain a more considerable brand reputation. Capacity expansion is expected to remain as the preferred competitive strategy for prominent market participants to stay competitive. For instance, in March

[15] https://www.who.int/news/item/03-03-2020-shortage-of-personal-protective-equipment-endangering-health-workers-worldwide

[16] https://www.cnbc.com/2020/03/30/3m-scrambles-to-meet-coronavirus-demand-for-face-masks.html

2020, Honeywell expanded its production capabilities in Phoenix to produce N95 face masks in support of the U.S. government's response to the novel coronavirus pandemic.

Some of the prominent players in the disposable face mask market include:

3M

The 3M Company is an American multinational conglomerate corporation operating in the fields of industry, worker safety, health care, and consumer goods. It is one of the world's largest manufacturers for surgical masks, including with attached face shields as well as N95 masks. As demand surges from healthcare professionals and first responders battling the coronavirus pandemic, 3M Co expects to ramp up U.S. monthly production of N95 respirator masks to 50 million in June 2020. The company is also looking to produce 2 billion N95 respirators globally within the next year.

Honeywell

Honeywell is one of the world's top 10 N95 mask manufacturers headquartered in Santa Ana, CA. Honeywell is a world's leading brand in personal protection equipment (PPE) products for different working environment such as chemicals, vapors and gas, welding, airborne particulates, and contamination. Some of its top selling products include non-disposable respirators, mask filters & cartridges and N95 masks with and without valves.

Kimberly-Clark Corporation

Kimberly-Clark Corporation is an American health and hygiene company that manufactures and provides personal care and consumer products. The Company's products include diapers, tissues, paper towels, incontinence care products, surgical gowns, and disposable face masks. Kimberly-Clark's key products, such as procedural, surgical and N95 masks, as well as face veils, filter, pleated, and children's masks are sold in countries around the world.

Ambu

Ambu A/S is a Denmark-based company engaged in the development, manufacture and marketing of diagnostic and life-supporting devices for hospitals and rescue services. The Company's operations are structured into three business areas: Anaesthesia, Patient Monitoring & Diagnostics and Emergency Care. Ambu offers a range of products from resuscitators, face masks and laryngeal masks to the single use flexible intubation scope for hospitals, clinics, and ambulance services.

BD

BD is a global medical technology company based in New Jersey, United States that is engaged in the development, manufacture and sale of a range of medical supplies, devices, laboratory equipment and diagnostic products. Their main products are used for infection control, medication management, medical supply management, diabetes care improvements and other goals across the healthcare system.

Prestige Ameritech

Prestige Ameritech is a leading domestic manufacturer of surgical masks and respirators in America and one of the top 10 respirator mask manufacturers in the world. Apart from facemasks and respirators, Prestige Ameritech also offers wide range of medical goggles, surgeons masks, and other products. Prestige Ameritech only serves customers in the United States.

Alpha Pro Tech

Alpha Pro Tech is an American medical tech company engaged in developing, manufacturing and marketing a line of disposable protective apparel and infection control products for the cleanroom, industrial, pharmaceutical, medical and dental markets. It is one of the largest

suppliers in the world for N95 respirator masks, as well as masks with and without shields, veils, and other medical personal protective clothing.

Louis M. Gerson Company, Inc.

Louis M. Gerson Co., Inc. is one of the leading medical suppliers in the world. The Company offers strainers, dispensers, bags, spreaders, spray socks, tack cloth, filters, respiratory masks, and related products. The Gerson Company currently has manufacturing capabilities in both the USA and China. The Company is ISO 9001:2008 certified for respiratory protection equipment for medical and industrial usages.

Teleflex

Teleflex Incorporated is a leading provider of medical technology products and one of the world's top 10 respirator mask manufacturers. The Company designs, develops, manufactures and supplies single-use medical devices used by hospitals and healthcare providers for diagnostic and therapeutic procedures in critical care and surgical applications. The company has over 30 manufacturing sites worldwide with manufacturing operations located in the Czech Republic, Germany, Malaysia, Mexico and the United States.

Moldex-Metric, Inc.

Moldex-Metric AG & Company KG manufactures respiratory and hearing protection products. The Company offers earplugs, earmuffs, medical masks, pleated filter technology, full face masks, and filter systems. Germany and the US are currently two of the largest market for Moldex-Metric's respiratory production products.

Shanghai Dasheng Health Products Manufacture Company, Ltd.

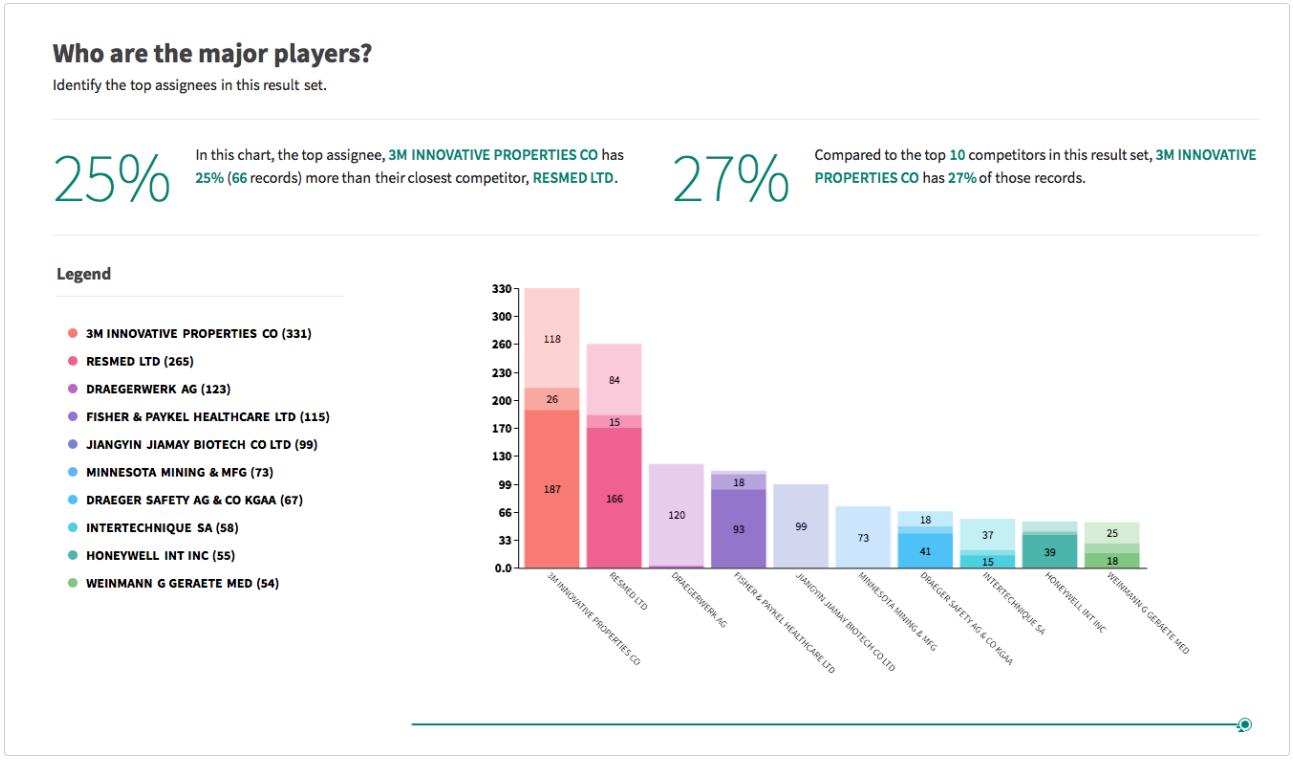
Shanghai Dasheng Health Products Manufacture Company is headquartered in Shanghai, China. The company passed the ISO9001 international quality management system certification, and offers European standard EN149 products and NIOSH regulated N95 and N99 respirator masks as well as medical and other masks and goggles.

Future Trends of Global Respirator Masks Market

The shift towards disposable devices in developed countries is one of the major disposable respiratory mask market trends which will further impact the market growth. Disposable masks eliminate the need for product sterilization and reduce cross-contamination with other reusable products. They are also cost-effective and prevent contamination and reduce hospital stay. Subsequently, countries like the UK and the US are moving towards the adoption of single-use or disposable products. The market is expected to move towards concentration during the forecast period. Many of the world's top 10 N95 mask manufacturers are now focusing on increasing their sales through direct sales force and online and retail marketing to help reduce promotional and operational costs.

An investigation using Derwent Innovation database by Clarivate Analytics Company has shown which are the most active players with the highest patent production in respirator mask sector.

The used database is one of the most complete in the World and used by many patent firms around the world. It has access to millions of data related to patent. The results of this analysis is shown in the following pictures.



The highest innovator in this field is 3M followed by Resmed. 3M covers around 30 % of patent production in this field.

Main industrial sectors are related to respirator products, hospital dialysis and technical textiles. The most active sector is respirator production, i.e. mask, in the last years. This means that a high number of patents have been deposited and, consequently, an active and innovative area is foreseen in respirator products line.

In the last years, mask and glove technologies are the highest active together with catheter and dialysis syringe.

The top 3 companies developing in these technologies in the last year are FISHER & PAYKEL HEALTHCARE LTD, 3M INNOVATIVE PROPERTIES CO and RESMED PTY LTD and they account for 80% of all records in the entire result set. These means that activity in innovation is very high in the last period for the major players: 3M and RESMED PTY LTD.

In the last picture, a patent trend in the last years is shown. It is very clear a constant growth in the last period and the high increase in the last year. This means that COVID pandemic situation of this 2020 spring starts to influence also innovation and patent trends.

How is the technology trending?

Identifies when a technology first appears and its evolution over time

82%

The top technologies in this space are **RESPIRATOR, FALL PROTECTION, BREATHING, LIFELINE, RESCUE, RESPIRATORY, HARNESS** and **CATHETER, PATIENT, SYRINGE, NEEDLE, BLOOD, INFUSION, DIALYSIS** and **GARMENT, GLOVE, APPAREL, CLOTHING, SHIRT, WEARER, WEARABLE** and they are found in **82%** of the result set. Larger percentages of tech interest show saturation in that space, whereas smaller percentages point to diverse tech representation.

6↑

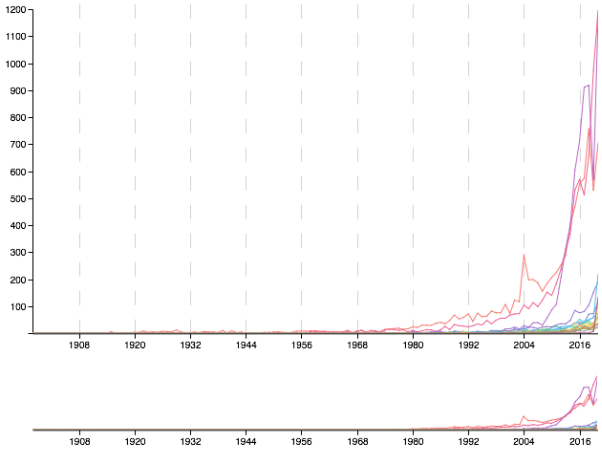
The top technology classification, **RESPIRATOR, FALL PROTECTION, BREATHING, LIFELINE, RESCUE, RESPIRATORY, HARNESS** peaked in **2018** and has trended **up** by an average **6** records per year.

100%

2015 represents the year with the most technological diversity with over **100%** of all technologies represented.

Legend

- RESPIRATOR, FALL PROTECTION, BREATHING, LIFELINE, RESCUE, RESPIRATORY, HARNESS
- CATHETER, PATIENT, SYRINGE, NEEDLE, BLOOD, INFUSION, DIALYSIS
- GARMENT, GLOVE, APPAREL, CLOTHING, SHIRT, WEARER, WEARABLE
- SURGICAL, ENDOSCOPE, MEDICAL, PATIENT, ULTRASOUND, BONE, TISSUE
- FILTER, MEMBRANE, SEPARATION, GAS, FILTRATION, CARBON DIOXIDE, SORBENT
- PROSTHETIC HEART VALVE, ABSORBENT ARTICLE, IMPLANT, PROSTHESIS, STENT, DIAPER, INTERVERTEBRAL
- TISSUE, SCAFFOLD, HYDROGEL, IMPLANT, MEDICAL, DRESSING, COLLAGEN
- HELMET, HEADWEAR, PROTECTING HEAD, PROTECTIVE HEADGEAR, VISOR, BRIM, CHIN
- EXOSKELETON, MASSAGE, REHABILITATION, CHEST COMPRESSION, WALKING, CARDIOPULMONARY RESUSCITATION, CPR
- CANCER, TREATING, ADMINISTERING, DISORDER, DISEASE, INHIBITOR, PHARMACEUTICAL
- DIVING, UNDERWATER, LIFE JACKET, SCUBA, RESCUE, WATERCRAFT, BUOYANCY
- SAMPLE, GAS SENSOR, CANCER, CELL, INSPECTION, ANTIBODY, BIOLOGICAL
- WHEELCHAIR, PATIENT SUPPORT, HOSPITAL, SURGICAL TABLE, STRETCHER, PERSON, MEDICAL
- MOLD, ADDITIVELY, THREE DIMENSIONAL PRINTING, ADDITIVE, COMPOSITE, BUILD, THERMOPLASTIC
- GOLF CLUB HEAD, EXERCISE, TREADMILL, FITNESS, HOCKEY, STRIKING
- LAMINATE, LAYER, COMPOSITE, RESIN, FILM, MULTILAYER, ADHESIVE
- CANCER, TREATING, ADMINISTERING, INHIBITOR, DISEASE, DISORDER, PHARMACEUTICAL
- NONWOVEN FABRIC, NANOFIBER, FILAMENT, FIBROUS, SPUN, BINDER, LAMINATE
- STIMULATION, NERVE, NEUROMODULATION, PATIENT, CARDIAC, IMPLANTABLE MEDICAL, PACING
- GARMENT, CLOTHING, APPAREL, SEAM, FABRIC, BRASSIERE, SHIRT



What technologies are being developed now?

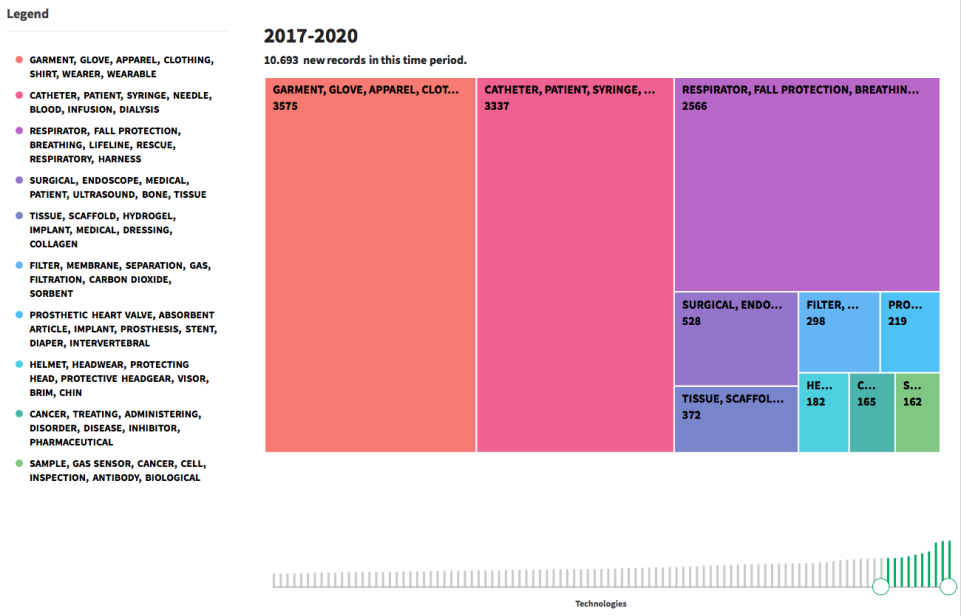
Uncover the most recent innovations and those that are new and growing

81%

Overall there are 30 technologies classifications represented in this chart. The top 3 technologies in last 4 years are GARMENT, GLOVE, APPAREL, CLOTHING, SHIRT, WEARER, WEARABLE and CATHETER, PATIENT, SYRINGE, NEEDLE, BLOOD, INFUSION, DIALYSIS and RESPIRATOR, FALL PROTECTION, BREATHING, LIFELINE, RESCUE, RESPIRATORY, HARNESS and they are found in 81% of the records in the result set.The number of technologies indicate recent innovations and can provide an overview of the "state of the market" and how it is segmented.

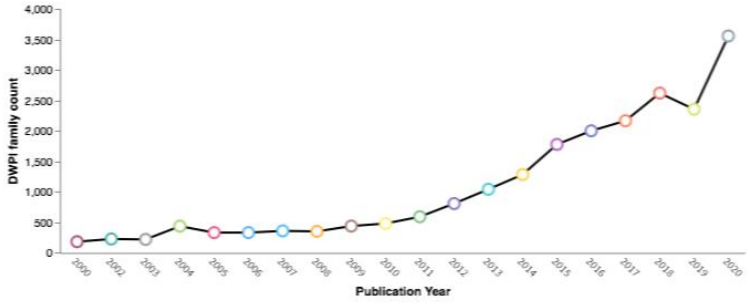
80%

The top 3 companies developing in these technologies now are [unspecified], 3M INNOVATIVE PROPERTIES CO and RESMED LTD and they account for 80% of all records in the entire result set.



Patent publishing trends

Created 2020-10-25



1. 2000(183)	8. 2008(352)	15. 2015(1778)
2. 2002(227)	9. 2009(439)	16. 2016(2001)
3. 2003(220)	10. 2010(481)	17. 2017(2165)
4. 2004(437)	11. 2011(592)	18. 2018(2619)
5. 2005(332)	12. 2012(808)	19. 2019(2354)
6. 2006(332)	13. 2013(1042)	20. 2020(3555)
7. 2007(360)	14. 2014(1284)	

4. Economic scenario

Last year, China made just over half of the world's masks. This year, the share is expected to climb to 85%. The global market for disposable masks was worth $75 billion in the first quarter of this year and is expected to grow at a rate of over 50% for the next seven years.[17]

Since the pandemic started, many companies have started producing masks, including carmaker. Around the world, entrepreneurs have started making masks, but not all are of sufficient quality to meet international standards. The United States, the Netherlands, Spain and Turkey have all rejected imported batches on quality grounds.

An interesting article[18] shows a table where medical waste by mask is calculated during COVID-19 in Asian Countries, see the following partial data table:

Table 1

Estimated daily face mask use and medical waste in Asia with confirmed COVID-19 cases.

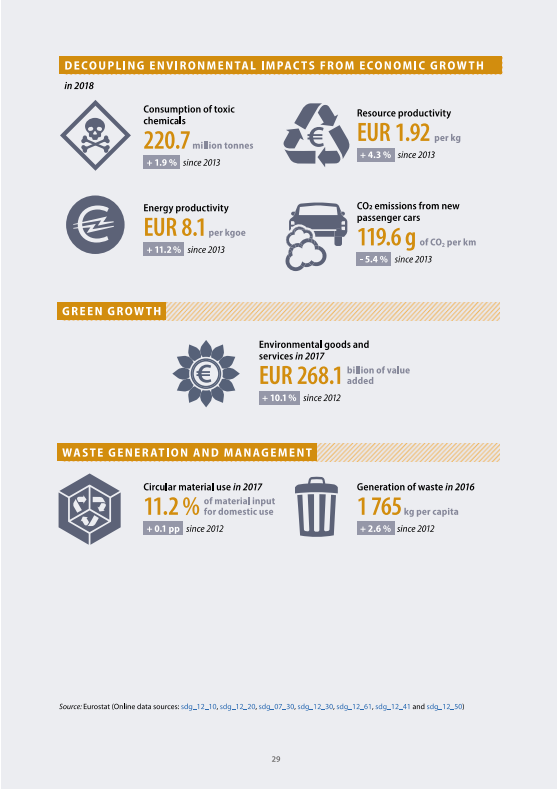
Country	[a]Population	[a]Total COVID-19 cases	[b]Urban population (%)	Face masks acceptance rate (%)	Number of face mask need of each general population each day	Total daily face mask use (pieces)	Medical waste (tons/day)
India	1,381,085,714	1,643,416	35	80	1	381,179,657	6,491.49
Iran	84,077,062	301,530	75	80	1	50,648,022	1,191.04
Pakistan	221,213,683	278,305	35	80	1	61,762,860	1,099.30
Saudi Arabia	34,855,542	274,219	84	80	1	23,367,155	1,083.17
Bangladesh	164,820,045	234,889	75	80	1	99,155,739	927.81
Turkey	84,410,984	229,891	39	80	1	26,066,112	908.07
Iraq	40,288,721	121,263	96	80	1	30,973,969	478.99
Qatar	2,807,805	110,460	60	80	1	1,341,008	436.32
Indonesia	273,753,080	106,336	73	80	1	159,214,791	420.03
Philippines	109,694,822	89,374	56	80	1	48,967,769	353.03
Kazakhstan	18,794,372	89,078	58	80	1	8,675,482	351.86
China	1,439,323,776	84,292	86	80	1	989,103,299	332.95
Oman	5,115,955	79,159	47	80	1	1,927,692	312.68
Israel	91,97,590	70,379	100	80	1	7,358,072	278.00
Kuwait	4,275,450	66,529	86	80	1	2,941,510	262.79
United Arab Emirates	9,899,794	60,223	100	80	1	7,919,835	237.88
Singapore	5,854,053	51,809	93	80	1	4,364,782	204.65
Bahrain	1,705,531	40,755	25	80	1	343,835	160.98
Armenia	2,963,706	38,196	89	80	1	2,114,901	150.87
Afghanistan	38,992,638	36,542	63	80	1	19,589,901	144.34
Kyrgyzstan	6,532,418	35,619	56	80	1	2,916,071	140.70
Japan	126,443,231	33,049	92	80	1	92,758,754	130.54
Azerbaijan	10,146,497	31,560	21	80	1	1,712,729	124.66

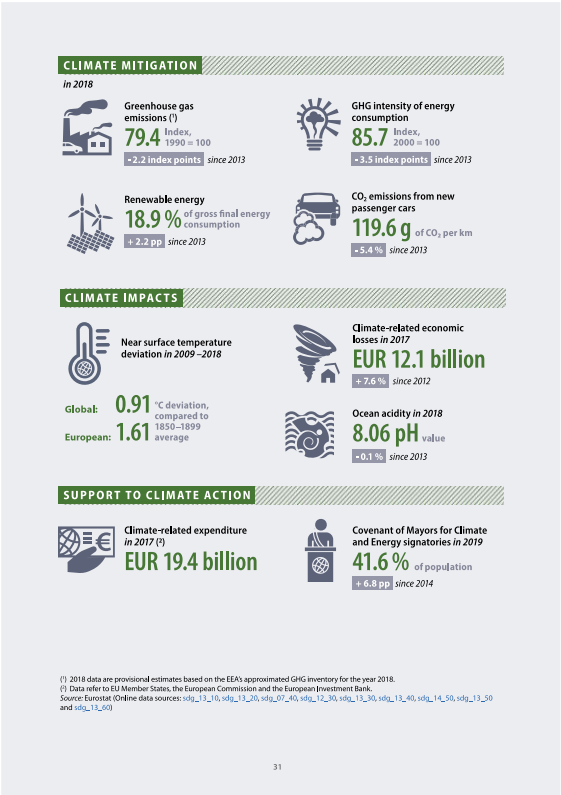
[17] https://www.grandviewresearch.com/industry-analysis/disposable-face-masks-market

[18] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7543915/

This study covers a large amount of world population (4,612,337,109) and it estimates a use each day of more of 2 billion of mask (2,228,170,832) with a production of around 17,000 tons of waste each day that actually is collected and send to landfill or incineration.

In Europe, the 'Overview of progress towards the SDGs in an EU context - 2020 edition'[19] underlines some facts regarding environmental impacts from economic growth and climate mitigation actions. See figures below. In particular, it is very interesting that 1.7 ton of waste for each habitant has been produced in 2016 and that 11% of input material goods is from circular material. The most important number is related to climate related expenditures: 19.4 billions in 2017. This number is the economic impact of each waste and pollution produced by industrial and domestic life. **If we reduce waste and pollution, we decrease the public climate related expenditures and, consequently, we have an economic benefit with reduction of climate related taxation and cost. COVID-19 pandemic situation creates a new source of waste that must be managed to avoid higher climate related expenditures.**





[19] Sustainable development in the European Union - Overview of progress towards the SDGs in an EU context - 2020 edition

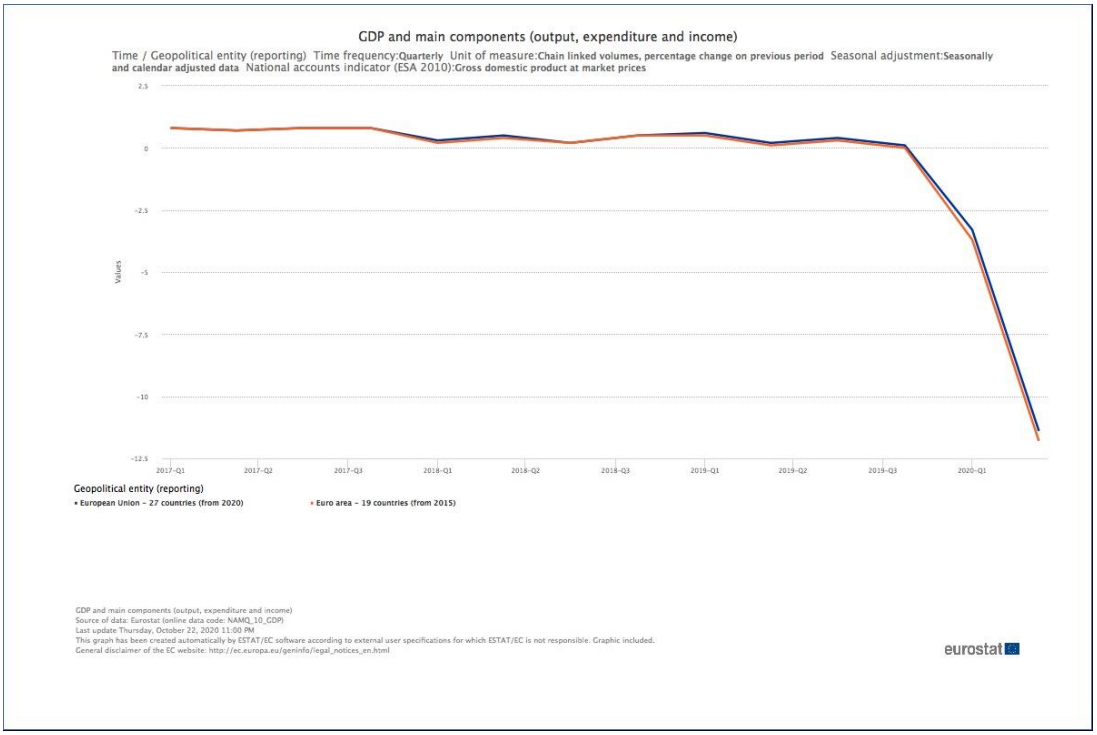
4.1. Europe and local area

According to the International Monetary Fund, 'the economic impact of the pandemic has been enormous' in Europe and the recovery 'will be irregular and partial'. In the newly released Regional Economic Outlook, the IMF predicts that Europe will suffer a 7% contraction in GDP in 2020 - it is expected to be the largest since World War II.

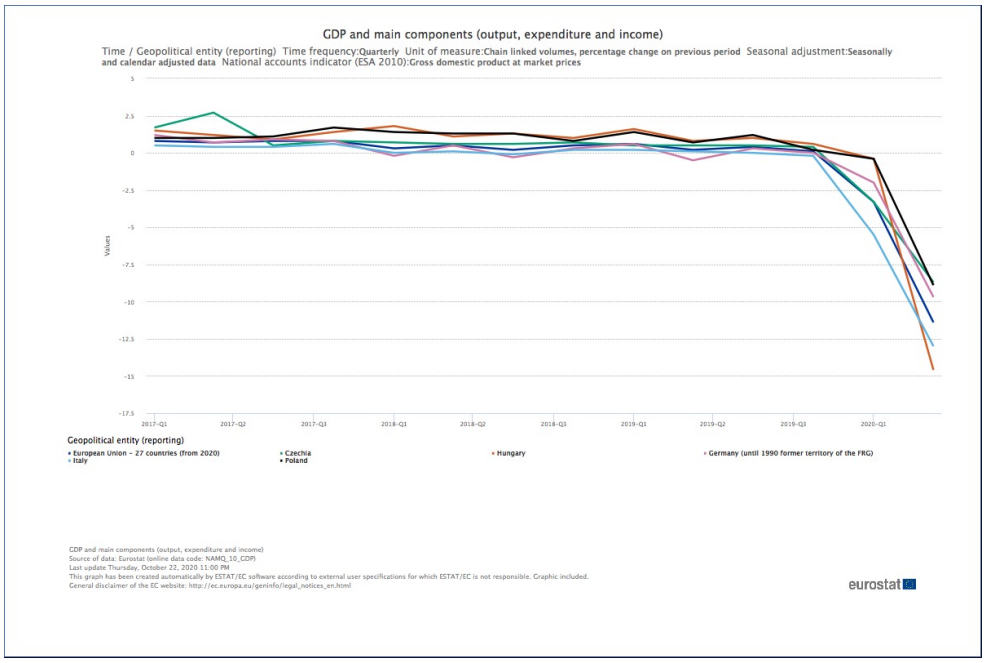
The June forecast was more pessimistic: they expected -8.5%. For Italy in particular, the IMF estimates GDP falling by 10.6% this year, with a rebound of 5.2% in 2021. In the light of these figures, Europe, according to the IMF, must do everything possible - whatever it takes - to contain the pandemic and its economic repercussions. In particular, it must not 'prematurely withdraw the stimulus to avoid repeating the mistake made during the global financial crisis'.

"Until the recovery is entrenched and the prospects for a vaccine improve, there is good reason to continue with the various policies that protect jobs", reads the newly released Regional Economic Outlook: there are estimated to be at least 54 million jobs protected by measures taken in Europe.

In economics, gross domestic product (abbreviated GDP) is a macroeconomic magnitude that measures the aggregate value, at market prices, of all final goods and services (i.e. excluding intermediate products) produced on the territory of a country in a given period of time (normally used as a reference for the calendar year, but other time frames are also used) It has gained a position of pre-eminence over its ability to express or symbolize the well-being of a national community relative to its level of development or progress.

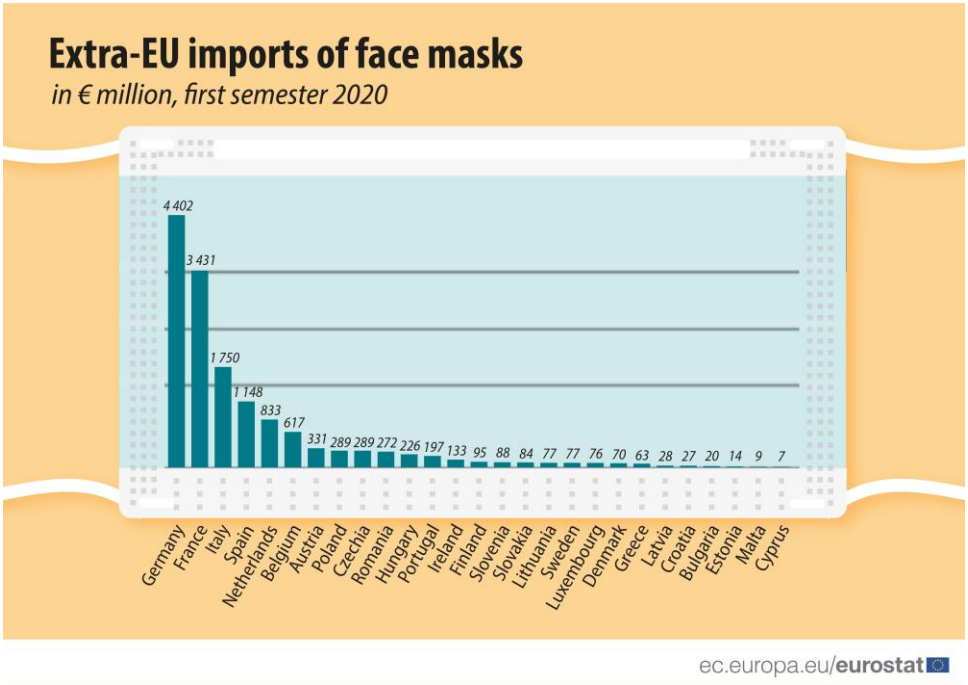


According to EUROSTAT Barometer, during COVID-19, first 2020 quarter, a drastic fall of GDP has been with dramatic numbers, more than 10% of losses, see figures above and below.



In the figure above, it is possible to see how all Countries investigated in this report (Italy, Poland, Czech Republic, Germany, Hungary) have the same trend as the global Europe one.

The high fall of GPD means a reduction of economic activities, less circulating money, strong difficulties for little activities. In parallel, a higher volume of waste production, due to mask, gloves, etc., increases climate related taxation and cost. This means that we have higher public cost and lower revenues by normal economic scenario pre-pandemic. A strong and dangerous mix that must be avoided.

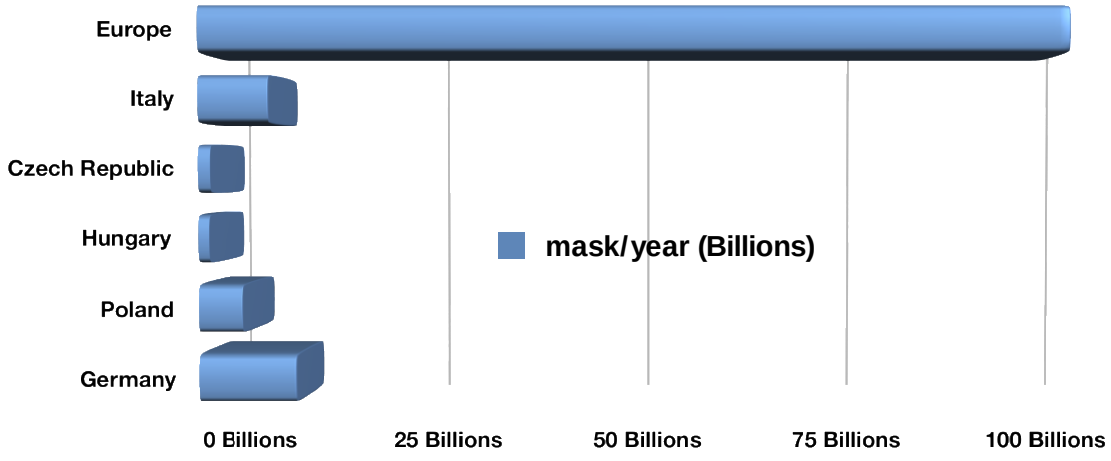


In the figure above, it is possible to underlines the mask import values for different European countries in the fir semester 2020.[20] Value for Italy is 1,750 Millions €.

According to all previous data and fact about use of mask during pandemic, we can assume the following hypothesis to calculate a global Europe scenario and local ones:

1 year of COVID situation in which we have 6 months of mask full use (100 % value of mask/day) and 6 months of partial use: (50% value of mask/day). The value of mask/day is calculated by data from article on Asian mask consumption, see page 17, and actual inhabitants numbers for Europe and local investigated countries[21], see tables and graph below.

	Asia	Europe	Italy	Czech Republic	Hungary	Poland	Germany
mask/day	2,228,170,832	358,938,828	29,021,676	5,140,311	4,636,968	18,166,373	40,216,292
habitants	4,612,337,109	747,789,224	60,461,826	10,708,981	9,660,351	37,846,611	83,783,942
Mask Coefficient use for habitants	0.48						
Mask/year (Billions)		96.91	7.84	1.39	1.25	4.9	10.86



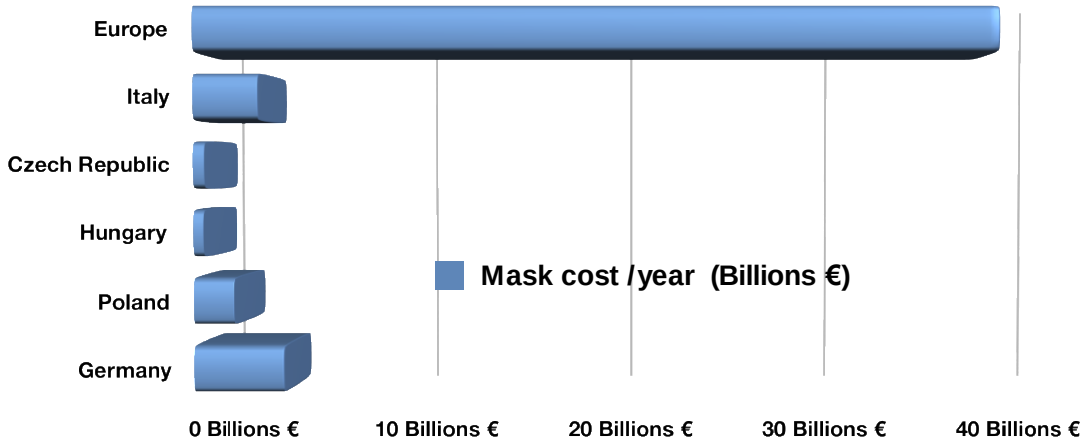
Assuming that selling price of one mask is around 0.5 € and that typical first revenue margin is 30%, it is possible to calculate a global cost (raw material, production, transport, logistic and distribution) of around 0.38 €. With this value, an estimation of global cost for mask use during pandemic in Europe and local countries is done. See the table and figure below.

	Europe	Italy	Czech Republic	Hungary	Poland	Germany
Mask cost/year	36.83	2.98	0.53	0.48	1.86	4.13

[20] https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20201006-1

[21] https://www.worldometers.info/world-population/europe-population/

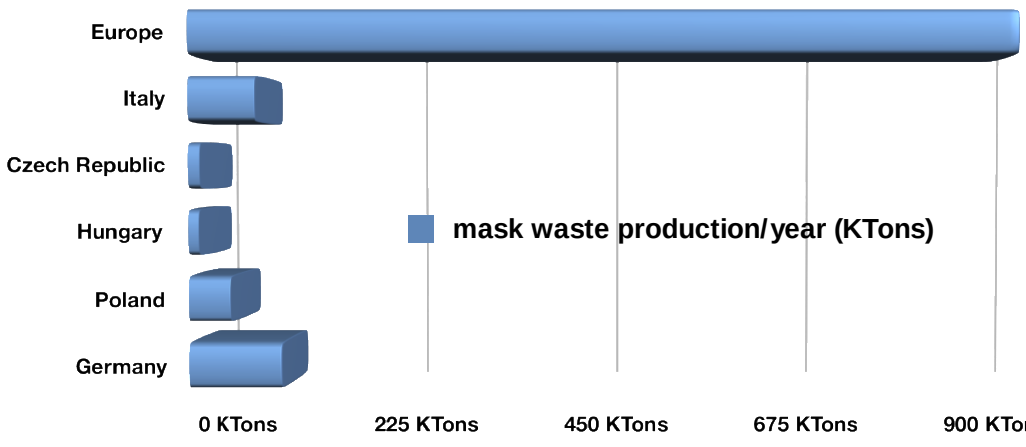
(Billions €)						



Calculated value for Italy is around 3 Billions €. EUROSTAT data indicates 1.75 Billions € imported mask in Italy for first semester 2020. Due to higher value at initial pandemic period and no internal production, calculated value is very near to actual data and indicates a confident scenario with initial hypothesis.

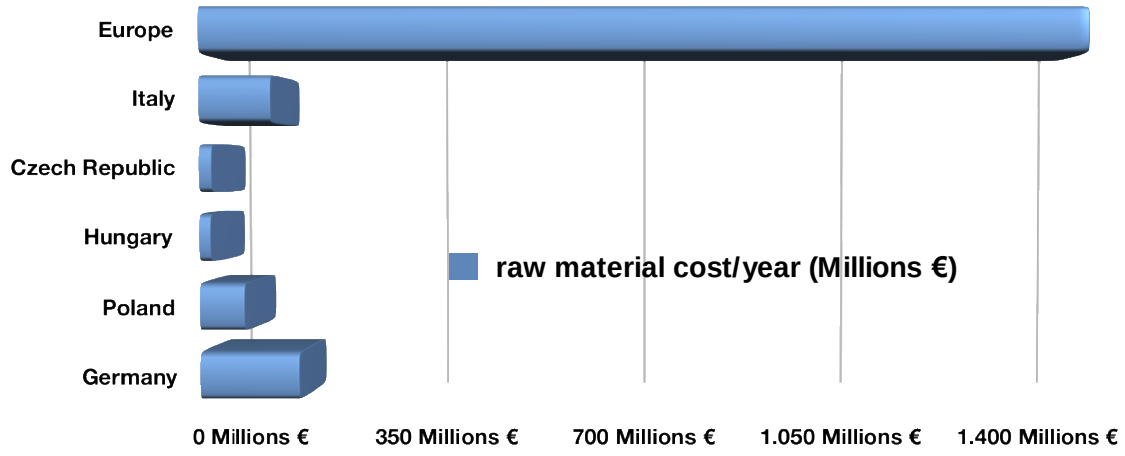
According to data from literature, it is possible to find mask weights from 5 to 15 grams. A medium value could be 8-9 grams. For the following table and graph related to waste production, the medium used value is 9 grams for each mask.

	Europe	Italy	Czech Republic	Hungary	Poland	Germany
mask waste production/year (KTons)	755.93	61.12	10.83	9.77	38.26	84.7



According to plastic market, a medium price22 for bowed polypropylene is 1.63 €/kg and 1.13 €/kg for polyester. A typical distribution of used mask material composition is 95% polypropylene and 5% polyester. With these parameters and previous tables of mask consumption, it is possible to calculate the cost of used raw material, see table and figure below.

	Europe	Italy	Czech Republic	Hungary	Poland	Germany
raw material cost/year (Millions €)	1,399.91	113.19	20.05	18.09	70.85	156.85



[22] http://www.bperestero.it/info/commodity/fibre-polipropilene-fiocco/

5. Two economic scenario: waste to landfill or waste recycle

From previous chapter 4, a scenario regarding consumption of mask in Europe and some Countries has been done. According to it, we can go deeper in an economic overview of what means this disruptive growing of mask use in Europe during Covid-19 pandemic.

The most effectively data are:

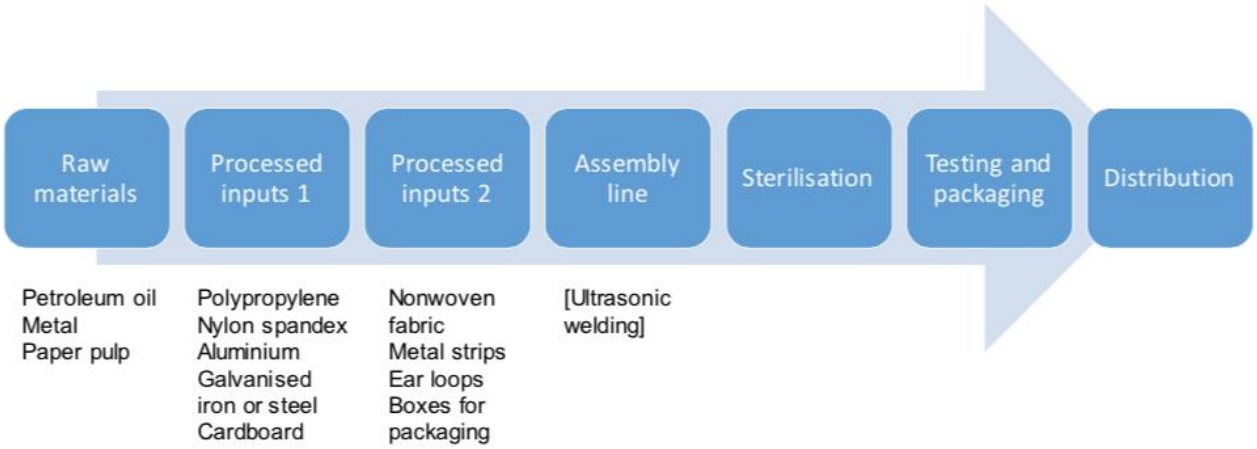
	Europe	Italy	Czech Republic	Hungary	Poland	Germany
Mask/year (Billions)	**96.91**	7.84	1.39	1.25	4.9	10.86
mask waste production/year (KTons)	**755.93**	61.12	10.83	9.77	38.26	84.7
Mask cost/year (Billions €)	**36.83**	2.98	0.53	0.48	1.86	4.13
raw material cost/year (Millions €)	**1,399.91**	113.19	20.05	18.09	70.85	156.85

From these data, a foreseen scenario is possible according to different final waste position: landfill/incineration or recycle.

Some general observation can be done. In particular, a big difference can be underlined between mask cost/year and raw material cost/year. The cost with all industrial chain from beginning to final user is much higher than the cost related to only raw material in bowed form. At Europe level we have 36,830 Millions € for global cost and 1,400 Million € for raw materials (Polypropylene and Polyester). This means that in economic evaluation for the different scenario, an important part is related to industrial chain to produce and sell the mask to the final user. The same figures, but with different values, are for single Countries.

Another important point that must be considered in economic evaluation is the GDP loss during pandemic period. This means that we can expect a lower petroleum price and consequently a drastic lower price for plastics production as Polypropylene and Polyester. In this scenario virgin raw material production of plastic is more convenient of recycle ones if we investigate only the raw material initial price without industrial chain and indirect cost (urban waste collection cost, tax for landfill collection, etc,, …) analysis.

COVID-19 has caused a dramatic shortage in the supply of face masks, which is mainly explained by a surge in demand. Since no country can meet the increase in the demand for masks alone, trade is essential. Export bans are harmful for countries without production capacity, but can also backfire on the country imposing them when they need to import inputs, additional masks or other essential goods. Tariffs or export licenses can delay trade, in addition to increasing prices. The smooth operation of transportation infrastructure and logistics, especially air cargo, is critical to support the face masks value chain during the crisis. More attention should also be given to the supply of key inputs. But free trade and trade facilitation are not enough to solve the current shortage; an important increase in supply is required in the short-term, requiring government planning and incentives for firms to convert existing assembly lines and create additional capacity. Certification procedures should be expedited to allow masks produced by new companies to be traded as soon as possible. In the following picture, mask production steps are shown.



Source: OECD, based on information provided by manufacturers.

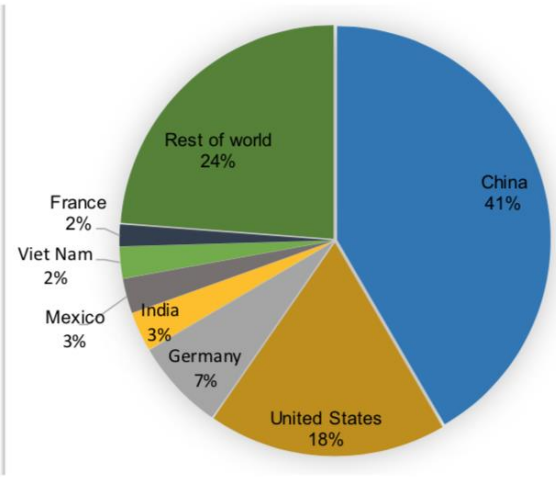
Looking ahead, it would be excessively costly for every country to develop production capacity that matches crisis demand and encompasses the whole value chain. An alternative, more effective and cost-efficient solution in the long-term may involve the combination of strategic stocks; upstream agreements with companies for rapid conversion of assembly lines during crises (with possible government incentives and co-ordination); and supportive international trade measures.

5.1. Waste to landfill

The actual scheme regarding waste by Pandemic situation (mask, gloves, gowns) is the delivery to landfill or incineration according to non-hazardous medical waste, first case, or special medical hazardous medical waste, second case.

In this situation, no-recycle is foreseen and destruction of all virgin raw material is done.

According to previous analysis, the following geographical area can be identified from a general point of view and before pandemic situation.



Note: Estimates based on trade flows observed for HS 630790 and using shares calculated with HS8 and HS10 trade data to identify face masks.
Source: UN COMTRADE and ITC Trade Map.

China is the most important producer and in Europe there was very little percentage of mask production before Pandemic situation.

Mask industrial chain identifies very well the assumption that raw material and productions are in China and waste from imported products are in Europe.

According to previous figure related to the mask industrial chain, before pandemic situation only distribution phase can be assigned mainly in Europe. All other phases are in China or others important producers (mainly U.S.A.).

From previous economic analysis about Mask production and use in Europe and local area, a global value of around 36.83 Billions € is foreseen. For production of mask, raw material cost is foreseen at 1.4 Billions. This value can be assigned to the first phase of production, raw materials, and to the second industrial phase, processed inputs 1, to reach producing of bowed Polypropylene and Polyester. The high difference between the two values, around 35.4 Billion €, is due to the other steps in industrial process where high revenue margins are applied.

Actually, due to pandemic situation with reduction of industrial and social activity, many Countries have applied lockdown or strictly procedures to avoid large diffusion of this virus, a parallel reduction in urban and industrial waste has been underlined. Because of it, landfills are not so full and a large fraction of them is free to accept volumes generated by mask and others PPE used by citizens and added to typical urban waste.

The most important problem to investigate is if mask and related COVID-19 PPE (i.e gloves) could be defined medical hazardous waste or not. From waste management point of view, there are significant differences. On the other hand, it is the possibility of disposing of all PPE (even those not coming from hospitals) as hazardous waste that is the most important issue. Their collection, transport and disposal costs are about 1,200-1,300 €/ton. Instead, for the not hospital hazardous waste, we speak at most of 130-150 euro/ton. [23]

Starting from these values, we can predict a cost to landfill from mask in Europe and local Countries, see table below.

Waste to landfill	Europe	Italy	Czech Republic	Hungary	Poland	Germany
Hazardous PPE (Millions €)	**113.39**	9.17	1.62	1.46	5.74	12.7
All Hospital hazardous PPE (Millions €)	**1,046.67**	84.63	14.99	13.52	52.97	117.27

The incineration process, instead, can avoid some problems related to contamination risks thanks to waste treatment high temperature but not in the management from urban collection to incineration place. Cost will be lower, but not so much.

If we adopt the pre-COVID situation, the Economic scenario for mask waste to landfill or incineration, a sum of cost without advantages is obvious for Europe and local Countries. In fact, before COVID all production phase is in China and out from Europe. In Europe remains only distribution and waste collection. This means that we have only cost, without revenues.

Instead, due to COVID situation, Europe needs to shift as many steps as possible of industrial chain to avoid lack in mask procurement, as evident in the first COVID phase during this spring. In this case, a higher volume of internal industrial process creates revenues in Europe that can equalize

[23] https://www.agi.it/cronaca/news/2020-05-24/coronavirus-smaltire-guanti-mascherine-8708290/

cost to manage waste incineration. It is better to speak of incineration, instead of landfill, because this process can generate energy and avoid some troubles with potential hospital hazardous waste.

5.2. Waste recycle

In the previous paragraph, an outline of economic scenario where waste is delivered in landfill or incineration has been underlined.

Another vision, instead, is to recycle waste with a secondary raw material production and new process. According to Circular Economy principles and Industrial Symbiosis, a recycle and recovery of waste produced by pandemic situation is a virtuous cycle that avoid waste increase in landfill and creates new secondary raw material to produce new goods in Europe done with these regenerated materials.

Secondary raw material approach is more often the most effective approach to reduce the lack in raw material supply. Some material, as rare earth family for electronic application are very difficult to find in Europe and to buy from Countries where are mines. Because of it, a strategy must be activated to assure the economic structure and independence of Europe. We have, instead, a lot of waste to be managed and each waste is a potential mine of secondary raw materials. Until now, very few cases of urban waste collection as secondary raw material have been conducted in Europe. Most famous case is plastic by bottle (PET) that has a full chain recollection by final user to industrial producer of new polymer and new plastic secondary raw material for industrial process. When urban waste is re-used with a Circular Economy approach, a strong and known technology must be distributed to all Europe industrial actors to avoid heavy logistic problems to transport waste from large geographical area in few industrial plants. Moreover, a minimal flow of secondary raw material is necessary to assure an industrial approach with enough amount of material to have continuous production lines. Waste recycle must be an industrial solution to a problem, not only a pilot or demonstration facility without economic and industrial approach.

Starting from this point of view, mask waste production during Pandemic period is an urban waste problem that must be solved with a similar approach used with PET bottle recycle:

- waste collection and sorting with a specific minimum geographical area
- industrial facilities to recycle waste and produce secondary raw material
- distribution of this secondary raw material in new industrial process for new goods.

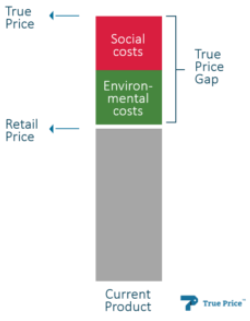
From previous data, if we assume that around 60% of waste can be effectively recycled, as in Europe for PET bottles[24], the following amount of secondary raw material (polypropylene and polyester) and valorization can be estimated for Europe and specific countries. About valorization we have done the same assumption of price and percentage of Polypropylene and Polyester. This valorization is if we have the same cost of production and selling price between virgin and secondary raw material.

	Europe	Italy	Czech Republic	Hungary	Poland	Germany
secondary raw material amount/year (kTons)	523.33	42.31	7.49	6.76	26.48	58.64
Economic Valorization	839.94	67.91	12.02	10.85	42.5	94.12

[24] https://www.statista.com/statistics/1166550/plastic-bottle-recycling-rates-in-select-countries/

(Millions €)						

This economic valorization, according to Circular Economy studies, must be corrected. Countries have committed themselves to ending poverty, hunger, slavery and climate change by 2030 through the Sustainable Development Goals (SDGs). How can we create an economy that does not require extracting more resources, in other words a circular economy? True prices are a part of the solution. Despite the growth of sustainability labels and organic products in shops, not a single shopping basket is truly circular and in line with the SDGs. Production processes pollute water, air and soil, deplete resources, and destroy biodiversity. This is in addition to social costs like underpayment and forced labor. These kinds of damages make up part of the true cost of a product that isn't not paid by the consumer, but instead by taxpayers, children, future generations, and people living in poverty. After all, taxpayers fund the repair of damage caused by extreme weather conditions and polluted living environments. Everything we buy has social and environmental costs, even organic jeans, local vegetables, and electric cars.



Research[25] shows that 40 euro jeans made from denim produced in India has a true price of 73 euros, partly due to the extraction of scarce water and the use of forced labor. To lower the true price of this product we must cultivate cotton more efficiently and stop forced labor. We could also lower the true price by applying circular principles such as reusing the denim from old jeans and treating wastewater after use.

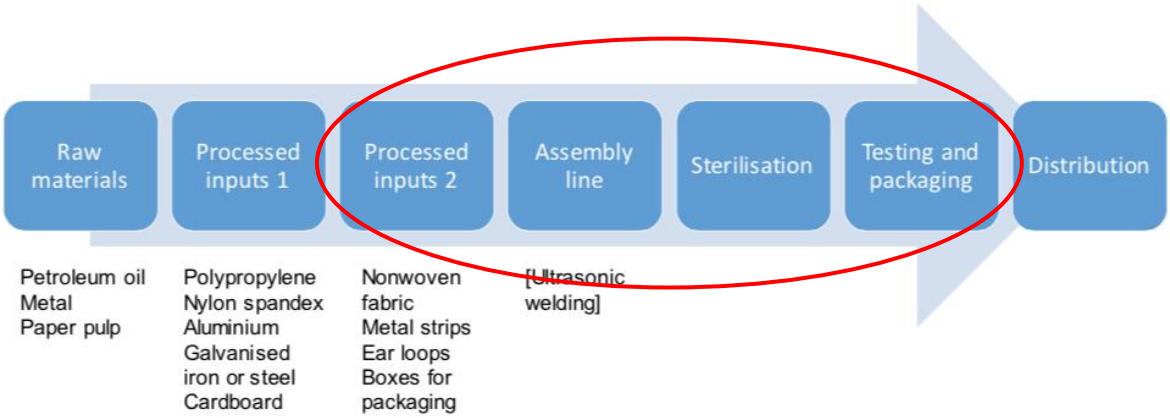
If we perform this approach to mask waste and actual production in Countries external to Europe, we can have an initial estimation of the true price:

		Europe	Italy	Czech Republic	Hungary	Poland	Germany
	Economic Valorization (Millions €)	839.94	67.91	12.02	10.85	42.5	94.12
Medium landfill waste cost	Mix hospital and Hazardous PPE (Millions €)	**580.03**	46.9	8.31	7.49	29.36	64.99
TRUE PRICE Initial Estimation		**1,419.97**	114.81	20.33	18.34	71.86	159.11

Calculation is done using a mix (50% ratio) between Hospital hazardous PPE and Hazardous PPE cost to landfill, as shown in previous table. The initial estimation of true price reveals a similar cost/price between virgin raw material and secondary raw material. At Europe level is around 1,400 Million € and 1,420 Millions € for secondary raw material. This model clarify that a circular approach must use different economic scenario to be investigated and, correctly, compared with the classical linear one.

In addition to this number, an internal market production of mask has other advantages. According to the industrial production we can have also the circled steps indicated in the following picture.

[25] https://trueprice.org/true-price-of-jeans/



Source: OECD, based on information provided by manufacturers.

If we calculate how much mask it is possible to produce internal by waste recycle, we can also have an idea about the money that remains in Europe and doesn't go to external market (mainly China) as a cost for people according to true price economic model.

	Europe	Italy	Czech Republic	Hungary	Poland	Germany
Mask internal market by waste recycle (Billions €)	**22.1**	1.79	0.32	0.29	1.12	2.48

According to this scenario, waste recycle of mask can generate an internal market with very high values and advantages to avoid both social and economic cost and, especially, to avoid supply lack during pandemic crise that close national borders and interrupts international linear industrial chain.

5.3. Comparison between the two scenario

In the previous two paragraphs, a picture of two different economic scenario has been done. The first result of this analysis is that pandemic situation has revealed a lack in industrial production chain according to actual linear model and an increase in waste production, especially as urban waste. Because of it, a strong effort has been done by all Europe Government to create new short and internal industrial production chains.

The first scenario, waste to landfill or incineration, is the common one until now. In fact, waste generated by citizens to protect against COVID-19 (mask, gloves, etc..) is normally catalogued as urban waste and collected without a specific sorting to landfill or incineration plants. This means that we destroy all residual value of these products and creates waste without a real production and economic valorization internal to Europe. Even if this solution seems to be the wrong one, at short time and during emergency of first disruptive COVID phase could be the easiest and the only one to be used.

As a secondary effect of pandemic, we have a lower petroleum price and consequently all derived plastic products, as that used for mask and gloves production. This means that we have a cheaper price of used raw materials. Together with it, a lower industrial production rate and a lower urban consumption rate creates lower waste production and, so, less waste to landfill or incineration. This two facts create a short time vision where no significant problems there are from waste generated by COVID situation.

This is wrong because we need to think at medium and long time, where COVID is still with us but industry and urban life are as before and with normal growth rate. In this case, waste generated to protect day by day is something that adds to other wastes and generates an increase in all climate dangerous parameters: plastic everywhere, CO_2 increase, pollution, microplastic contamination of water, etc., …

The second economic scenario, waste recycle, instead, tries to answer at these problems with a Circular Economy approach of waste by COVID. In this case, thanks to recycle of waste we can have a short industrial process line internal to Europe or local countries. This means that we create value by products and by waste. This advantage is possible to reach only with a high innovation action to resolve technical problems related to recycle of mask: waste sorting at urban level, sanitation and finishing removal, new industrial application of waste as secondary raw materials. Circular Economy and Industrial Symbiosis are well known actions of Europe programs in this year and for next years. We have best practices and famous cases related to Pet of bottles, paper, electronic components, etc., ...

COVID-19 situation can create conditions for a strong effort to apply these concepts to real large cases with a double advantages: independence of industrial production line by external factors, for example a pandemic as COVID, and valorization of production in an internal market without full import of goods. If, as supposed in previous analysis, we succeed in this, an internal market of around 22 Billion € is foreseen avoiding, instead, a buying market from other countries without a real industrial production and selling chain, with a Circular Economy full approach.

6. Conclusions

COVID 19 is spreading around the world, causing deaths and major disruption to the global economy. Manufacturers across the world are producing three types of mask – surgical masks, respirators and cloth face coverings. In European Countries, a different approach has been established to block COVID-19 transmission, and consequently, different results in this strong world battle again epidemic. For example, in Italy, during first round of COVID pandemic, from March to April, some analysis has been done to determinate mask amount necessary for medical purpose and citizens protection.

In the pandemic situation caused by COVID-19, there is an increment of medical single-use personal protection equipment and consequently an increment of the medical waste not only deriving from hospitals and clinics but also from the population with a mass use to prevent the spread of the virus. Last year, China made just over half of the world's masks. This year, the share is expected to climb to 85%. The global market for disposable masks was worth $75 billion in the first quarter of this year and is expected to grow at a rate of over 50% for the next seven years.

This production of goods generates waste in Europe. The most important number is related to climate related expenditures: 19.4 billions in 2017. This number is the economic impact of each waste and pollution produced by industrial and domestic life. If we reduce waste and pollution, we decrease the public climate related expenditures and, consequently, we have an economic benefit with reduction of climate related taxation and cost. COVID-19 pandemic situation creates a new source of waste that must be managed to avoid higher climate related expenditures.

According to the International Monetary Fund, 'the economic impact of the pandemic has been enormous' in Europe and the recovery 'will be irregular and partial'. In the newly released Regional

Economic Outlook, the IMF predicts that Europe will suffer a 7% contraction in GDP in 2020 - it is expected to be the largest since World War II. The June forecast was more pessimistic: they expected -8.5%. For Italy in particular, the IMF estimates GDP falling by 10.6% this year, with a rebound of 5.2% in 2021.

COVID-19 has caused a dramatic shortage in the supply of face masks, which is mainly explained by a surge in demand. Since no country can meet the increase in the demand for masks alone, trade is essential. Export bans are harmful for countries without production capacity, but can also backfire on the country imposing them when they need to import inputs, additional masks or other essential goods. Tariffs or export licenses can delay trade, in addition to increasing prices. The smooth operation of transportation infrastructure and logistics, especially air cargo, is critical to support the face masks value chain during the crisis. More attention should also be given to the supply of key inputs. But free trade and trade facilitation are not enough to solve the current shortage; an important increase in supply is required in the short-term, requiring government planning and incentives for firms to convert existing assembly lines and create additional capacity. Certification procedures should be expedited to allow masks produced by new companies to be traded as soon as possible.

If we adopt the pre-COVID situation, the Economic scenario for mask waste to landfill or incineration, a sum of cost without advantages is obvious for Europe and local Countries. In fact, before COVID all production phases are in China and out from Europe. In Europe remains only distribution and waste collection. This means that we have only cost, without revenues.

Instead, due to COVID situation, Europe needs to shift as many steps as possible of industrial chain to avoid lack in mask procurement, as evident in the first COVID phase during this spring. In this case, a higher volume of internal industrial process creates revenues in Europe that can equalize cost to manage waste incineration. It is better to speak of incineration, instead of landfill, because this process can generate energy and avoid some troubles with potential hospital hazardous waste.

Another vision, instead, is to recycle waste with a secondary raw material production and new process. According to Circular Economy principles and Industrial Symbiosis, a recycle and recovery of waste produced by pandemic situation is a virtuous cycle that avoid waste increase in landfill and creates new secondary raw material to produce new goods in Europe done with these regenerated materials. Secondary raw material approach is more often the most effective approach to reduce the lack in raw material supply.

According to this scenario, waste recycle of mask can generate an internal market with very high values and advantages to avoid both social and economic cost and, especially, to avoid supply lack during pandemic crisis that close national borders and interrupts international linear industrial chain.

COVID-19 situation can create conditions for a strong effort to apply these concepts to real large cases with a double advantages: independence of industrial production line by external factors, for example a pandemic as COVID, and valorisation of production in an internal market without full external import of goods. If, as supposed in previous analysis, we succeed in this, **an internal market of around 22 Billion € is foreseen** avoiding, instead, a buying market from other countries without a real industrial production and selling chain, with a Circular Economy full approach.