WP T2 – INNOVATION ON TEXTILE WASTE MANAGEMENT

ACTIVITY A.T2.3 PILOT CASES

D.T2.3.4 PILOT CASES FEASIBILITY STUDY

Partner:
PP7 INOTEX Ltd. (INOTEX)
PP8 ČTPT (CTPT)
(Czech Republic)

Version 1
09 / 2020

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)

ENTeR - Expert Network on Textile Recycling

ENTeR works in five central European countries that are involved in the textile business, to promote innovative solutions for waste management that will result in a circular economy approach to making textiles.

The project will help to accelerate collaboration among the involved textile territories, promoting a joint offer of innovative services by the main local research centres and business associations ("virtual centre"), involving also public stakeholders in defining a strategic agenda and related action plan, in order to link and drive the circular economy consideration and strategic actions.

The approach of the proposal and the cooperation between the partners is oriented to the management and optimization of waste, in a Life Cycle Design (or Ecodesign) perspective.

CONTENT

1. Pilot case description – aim and scope

The Pilot case "Textile waste coming from medical devices concerning COVID-19 emergency"

The COVID-19 pandemic has revealed the urgent need for large number of disposable textile medical devices both for the healthcare workers (surgical gowns, medical masks, respirators, surgical drapes, gloves) as well as for the citizens (protective face masks). The dramatic increase in their use is leading to significant increase of waste production worldwide.

The additional pilot case of the ENTeR project "Textile waste coming from medical devices concerning COVID-19 emergency" aims to define a potential new way for medical textile waste management in order to favour their recycling and /or reuse. The aim is to study the medical textile waste materials (material, chemicals, biological contamination), to define current procedures for medical textile waste management, to study removal of chemicals and biological decontamination, to evaluate economic and environmental benefits of it´s reuse / recycling and to create guidelines and best practices for a new and more sustainable waste management

In Czech Republic, wearing of the face masks was mandatory from 19th March 2020 till end of June 2020 and is mandatory again after the summer break from 1st September 2020. As there was a lack of the the disposable face masks in Czech Republic at the beginning of the covid-19 pandemic situation, this product was not available on the market and the emergency supplies were restricted by the government to be supplied exclusivelly to the hospitals, doctors at ambulances and to other first response health services. To be compliant with the obligations according to the government action, the Czech citizens proactively started to sew the face masks from textile fabrics (100% cotton strongly preferred) at home.

Outside the ENTeR project, INOTEX in cooperation with external partners has developed the textile fabric with special treatment which is used for production of the textile face masks „FreshDye". These masks work on principle of the fotoactive dyestuff which after irradiation with common daylight generates the short-term reactive forms of oxygen; thanks to that, the mask is protected against the pollutants including aproved antibacterial effect. Thanks to that effect, it is not necessary to wash the masks at 100°C to decontaminate them; textile can be washed at 60°C. The approved durability of the photocatalytic dyeing at minimum 50 washing cycles prolongs the service life in comparsion to 100% cotton masks and significantly reduces amount of waste in comparison with disposable masks.

Within the pilot case, reduction of generated textile waste from disposable masks thanks to the „FreshDye" face masks will be evaluated.

2. Legislation related to waste from used face masks

2.1. Handling of waste from the used face masks with respect to COVID-19

During the COVID-19 pandemic, the Czech National Reference Centre and Ministry of Environment have published reccomendations and guidances for safe handling of waste related to COVID-19, including handling the used face masks from public as well as from the health care sector. (2, 3)

According to these reccomendations, the methods of handling the used face masks vary depending on whether or not the waste comes from a source without risk of infection or from a source where infection can be expected. The details are described in the following chapters.

2.1.1. Municipal waste from healthy persons

The municipal waste from healthy persons can be handled in the same manner as usualy. The used disposable face masks from people who are not infected or not in quarantine can be disposed of in mixed municipal waste if they are placed in a small plastic bag and than in a plastic waste bag (used normally for disposal of the waste from households). (3)

2.1.2. Municipal waste from persons with confirmed COVID-19

People with confirmed COVID-19 disease in home isolation and people in home quarantine should get instructions on how to dispose of their waste as part of quarantine measures.

Their waste should not be sorted. All the non-sorted waste (including face masks and tissues) generated in their household shall be disposed of in the plastic bags with minimum thickness 0,2 mm. When the bag is full (but no later than within 24 hours), the bag shall be tightly tied and treated with disinfectant on the surface.

In case the used plastic bag is made from a thinner material, it is necessary to use double packaging: the first plastic bag must be placed into the secong bag, tied and the surface of the outer bag treated with disinfectat.

The tightly closed bag should than be left only in the disposal bin or container for mixed municipal waste; in principle, not to leave bags outside containers, due to the accidental damage. (3)

2.1.3. Workplaces without risk of infection

These workplaces are e.g. administrative activities, offices, shops or professionals without risk of infection. The waste from used PPEs shall be listed under the code *20 03 01 Mixed municipal waste* (according to European Waste Catalogue and Waste Catalogue according to Czech Decree 98/2016 Coll.)

The disposed used PPEs should be placed into the two plastic bags and tightly tied; surface of the outer bag shall be treated with disinfectant. Bags shall be disposed in the disposal bins or containers for mixed municipal waste. Bags mustn´t be left outside the container. (2)

2.1.4. Industrial enetrprises without risk of infection

Waste from the used PPEs shall be listed under the code *15 02 03 Absorbents, filter materials, wiping cloths and protective clothing* (other waste) (according to European Waste Catalogue and Waste Catalogue according to Czech Decree 98/2016 Coll.).

The rules for handling are the same as in previous cases: to use double plastic bags packaging, to disinfect outer bag´s surface and to leave the bag only in the waste container. (2)

2.1.5. Workplaces with risk of infection

The used disposable PPEs must be considered as hazardous waste. Handling of them is governed by the general rules for management of infectious waste. These waste shall be listed under the

code *15 02 02* Absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances (HP 9 - infectivity).*

The used PPEs must be placed safely in labelled, separated, closed and mechanically resistant packagings, preferably combustible without the need for further handling of waste. The waste producer is obliged to provide the safe packaging for hazardous waste. The infectious waste must be disposed of immediately in a hazardous waste incinerator. (2)

2.1.6. Medical and similar facilities

These wastes must be listed under the code *18 01 03* Wastes whose collection and disposal is subject to special requirements in order to prevent infection (HP 9 - infectivity).*

Wastes (including the face maks) from the medical and similar facilities (hospitals, clinics, homes for erderly people, social services homes, hospices, individual doctors) are under the scope of the medical waste legislation. The infectious waste must be immediately disposed of in a hazardous waste incinerator. Highly infectious waste must be decontaminated immediately by certified technological facility (facility with validated decontamination technology with verified efficiency). (2, 4)

In Czech Republic, the legal obligations concering the medical waste are defined by Waste Act No. 185/2001 Coll., Decree 383/2001 Coll. and Decree 306/2012 Coll.

2.2. Decontamination and processing of used PPEs from health care facilities from the regulatory point of view

2.2.1. Legislation related to health care waste decontamination and use in Czech Republic

Management of waste from medical facilities is generally governed by the Act (No. 185/2001 Coll. on waste). At the same time, the waste producer is obliged to proceed with the management of specific waste in accordance with special regulations.(16)

The health care waste is waste listed in group 18, subgroup 18 01 of the Waste Catalog. It includes waste originating from the provision of health care in inpatient, outpatient medical facilities or similar facilities; waste arising from health care provided in the patient's own social environment; waste generated outside medical facilities (e.g. social care facilities, tattoo parlors, drug centers, etc.). The used PPEs (including the face masks) from health care service facilities generated during the COVID-19 pandemic are considered as infectious waste, therefore must be classified as waste category *18 01 03* wastes whose collection and disposal is subject to special requirements in order to prevent infection (HP 9 - infectivity).* (4, 5)

The health care waste has to be sorted (separately collected); sorting takes place at the place of waste generation, i.e. at each workplace (surgery, room, operating room, waiting room etc.). Each sorting bin must be labelled according to Decree 383/2001 Coll., including the catalogue code of the waste. Waste collection devices are removed from the workplace of the medical facility (from surgeries, wards, etc.) daily. The removal is carried out immediately after filling the collection bins, or after the end of working hours, in case of the continuous workplaces at the latest once every 24 hours. (4, 5)

Specific conditions for the management of infectious waste in medical and similar facilities and the method of its disposal are set out in the operating rules of the medical facility and the operating rules of the waste management facility.

The infectious waste must be immediately disposed of in a hazardous waste incinerator. Highly infectious waste must be decontaminated immediately by certified technological facility (facility with validated decontamination technology with verified efficiency).(4)

According to Annex 4 of the Act 383/2001 Coll. on waste, the decontamination is listed into the methods of waste disposal under the codes *D8 Biological treatment not specified elsewhere in this Annex which results in final compounds or mixtures which are discarded by means of any of the operations numbered D1 to D12* or *D9 Physico-chemical treatment not specified elsewhere in this Annex which results in final compounds or mixtures which are discarded by means of any of the operations numbered D1 to D12. D*econtamination is one of the methods that are recommended to reduce the risk of infectious waste before its transport from the medical facility to the final removal.

To decontaminate health care waste, it is possible to use various types of equipment with validated decontamination technology with demonstrably proven effectiveness; these technologies are based primarily on principles of steam sterilization, microwave heating, their combinations, etc. The facility operating the decontamination device must be operated only on the basis of an authorisation granted by the relevant local authority. (In Czech Republic, it means that the facility will be granted with ID number - IČZ). If the decontamination device is part of the own waste management system and is located at the place of waste generation (e.g. microbiological laboratory), then the facility is not obliged to apply for authorisation; but waste from other departments (i.e. of the same subject) or from other medical facilities would have not be received and treated at this decontamination device. This method of decontamination is operated at workplaces where highly infectious waste is generated, which must be treated directly by decontamination with certified technological equipment in direct connection with its generation. This is health care waste that is expected to occur with a high probability that it will contain biological agents of the 3rd and 4th class of pathogenicity in the sense of special regulations and must always be modified immediately after its origin. (4, 5) The efficiency of the decontamination equipment has to be checked on the basis of physical, chemical and biological indicators. (16)

There are many various systems for decontamination of health care waste on a market which reduce number of pathogenic organisms; the waste than loses its dangerous property H9 – infectivity and can be further managed as other waste. Some examples are described in chapter 2.2.2.

It is necessary to highlight that after decontamination, the resulting product remains to be considered waste. It just loses the hazardous property H9 – infectivity. After sorting all hazardous components of the waste, which could make the waste hazardous in terms of other hazardous properties and after decontamination of the waste, it can be managed as other waste and classified under waste category *18 01 04 wastes whose collection and disposal is not subject to special requirements in order to prevent infection.* Decontaminated health care waste can be burned in municipal waste incinerator or landfilled. (16) Reuse of decontaminated materials might be possible only under the strict safety and hygienic conditions. In principle, such a treated waste shall be initially considered a "hazardous" waste; to classify it as "other", it would be necessary to do "withdrawal" according to Decree No. 94/2016 Coll. on the evaluation of hazardous properties of waste, issued only by authorised person. Examples is described in chapter 2.2.2. or in Deliverable *D.T2.3.2_Pilot Cases_INOTEX medical devices covid-19* (chapter 2.4.1). (4, 15)

It is also important to notice that actually, the new Act on waste is going to be approved in Czech Republic at autumn 2020 with expected efficiency from 1st January 2021.

3. Feasibility study

3.1. State purchase of the single-use medical face masks in Czech Republic during COVID-19 pandemic

In 2018, the Global Respiratory Protective Equipment market accounted for $5.58 billion; it is expected to reach $11.93 billion by 2027 growing at a CAGR of 8.8%. (7) The global face masks market was valued at 1,20 Billion USD in 2019. (6) During the period 2019-2025, the face masks market by unit shipment is expected to grow at a CAGR of over 5%. (8)

Now, there is the sudden increase due to the COVID-19 pandemic. The face masks are used by people worldwide as a physical barrier, to prevent the spread of the virus from the wearer. Some countries require the mandatory use of the face masks in public places. According to WHO, the reuse of the masks is not recommended and the masks should to be replaced. During the COVID-19 pandemic, the face masks are worldwide widely adopted in hospital and health care sectors,industry, supermarkets, stores, poublic transport or government departments. Due to this, the face masks market has unprecedently grown during past few monts and the further wrowth is expected for the periiod 2020-2026, as demonstrated in the Fig.1. (6)

Fig. 1 : Face Masks Market Size in period 2017-2026 (6)

Worldvwide, there are approx. 400 vendors whi offer the various kinds of face masks. Concerning the COVID-19 pandemic, the number of companies manufacturing COVID-19 face masks has increased exponentially, especially in China, over the last two decades. Around 50% of the global production is manufactured in China alone. (8)

In the Czech Republic, the use of the face masks by all citizens was obligatory from 19th March 2020 according to the government action on coronavirus. As also in many other countries, there was the serious lack of the the disposable face masks in Czech Republic at the beginning of the covid-19 pandemic and this product was not available on the market; therefore, the emergency supplies were restricted by the government to be supplied exclusivelly to the hospitals, doctors at ambulances and to other first response health services. Some quantities of disposable PPE were distributed to police and other security services being in the potential risk of direct contact with infected people. The Czech government coordinated the public pourchase of the PPEs (face masks, respuiratory masks, gloves, protective shields, disinfectants, protective cloths etc.) for these public sectors via Ministry of Interior; the purchased PPEs were than re-distributed to individual regions.

Concerning the single-use medical face masks, as of 8th June 2020 the Czech Ministry of Interior has purchased a total of 139.300.000 pieces in the total price 1.373.046.533 CZK. This amount was re-distributed into the regions: as of 12th May 2020, 24.130.850 pieces was re-distributed for healthcare sector, 9.745.950 for social services and 7.962.090 for other sectors, it means in total 41.833.890 pieces of single-use medical masks.

In the tables bellow, the public purchase and distribution of the face masks organized by Ministry of Interior are summarised.

Supplier	Item	Pcs.	Price/pc	Total price		Paid in currency
				In currency	Paid (ČNB [1] exchange rate)	
Guoyao Xingchu Technological Industry	Face masks	25. 000.000	0,3855 USD	9.637.500,- USD	227.117.325,00 CZK	USD
Guoyao Xingchu Technological Industry	Face masks	5.000.000	0,3855 USD	1.927.500,- USD	45.423.465,00 CZK	USD
Xiantao Dingcheng Non-woven Products Co. Ltd	Face masks	5.000.000	0,386 USD	1.930.000 USD	49.591.350,00 CZK	USD
Kunshan Jiehong nonwoven Product co.,Ltd.	Face masks	30.000.000	0,3851 USD	11.553.000 USD	296.854.335,00 CZK	USD
Xiantao Zhongyii Sagety and Protection	Face masks	12.000.000	0,35 USD	4.200.000 USD	104.823.600,00 CZK	USD
Kunshan Jiehong nonwoven Product co.,Ltd	Face masks	60.000.000 (10+25+25)	0,3851 USD	23.106.000 USD	98.115.778,00 CZK 242.093.115,00 CZK 236.990.540,00 CZK	USD
Beijing YuanyeHengxing International Trading Co., Ltd.	Face masks	500.000	0,8 USD	400.000 USD	27.330.550,00 CZK	USD
nanoSPACE s.r.o.	Face masks from nanofibers	50.000 pcs per week / 4 weeks	49,- CZK without VAT	11.858.000,- CZK incl.VAT	1.422.960,00 CZK 1.541.540,00 CZK 2.668.050,00 CZK 3.260.950,00 CZK	CZK
SPUR a.s.	Face masks from nanofibers	200.000 pce per week / 4 weeks	37,- CZK without VAT	35.816.000,- CZK incl. VAT	4.477.000,00 CZK 4.477.000,00 CZK 7.498.975,00 CZK	CZK
Batist Medical a.s.	Face masks from nanofibers	200.000 pce per week / 4 weeks	20,- CZK without VAT	19.360.000,- CZK incl. VAT	4.840.000,00 CZK 4.840.000,00 CZK 4.840.000,00 CZK 4.840.000,00 CZK	CZK

[1] ČNB = Czech National Bank (Česká národní banka)

Tab. 1 : The public purchase of protective medical face masks
by Ministry of Interior of Czech Republic (as of **8th June 2020**) (9)

Distribution as of the date: *12th May 2020* All regions in total		**Number of pieces in thousands**
		Face masks
Healthcare sector	Bed medical facilities	12 018,34
	Ambulance	1 066,75
	Outpatient sector	11 045,76
Healthcare sector in total		**24 130,85**
Social services	Bed facilities established by region	2 883,95
	Bed facilities not stablished by region	3 420,01
	Field (outpatient) sector	3 441,99
Social services in total		9 745,95
Other		7 962,09
Liberec Region		**Number of pieces in thousands**
		Face masks
Healthcare sector	Bed medical facilities	1 159,00
	Ambulance	238,00
	Outpatient sector	288,05
Social services	Bed facilities established by region	66,25
	Bed facilities not stablished by region	81,85
	Field (outpatient) sector	91,75
Other		8,82
Zlín Region		**Number of pieces in thousands**
		Face masks
Healthcare sector	Bed medical facilities	1 011,40
	Ambulance	52,50
	Outpatient sector	501,70
Social services	Bed facilities established by region	336,20
	Bed facilities not stablished by region	468,50
	Field (outpatient) sector	228,10
Other		10,80
Moravian-Silesian Region		**Number of pieces in thousands**
		Face masks
Healthcare sector	Bed medical facilities	759,30
	Ambulance	35,00
	Outpatient sector	1 341,77
Social services	Bed facilities established by region	237,76
	Bed facilities not stablished by region	436,40
	Field (outpatient) sector	154,59
Other		1 677,50

Central Bohemia Region		**Number of pieces in thousands**
		Face masks
Healthcare sector	Bed medical facilities	1 440,40
	Ambulance	35,00
	Outpatient sector	1 039,09
Social services	Bed facilities established by region	480,95
	Bed facilities not stablished by region	442,18
	Field (outpatient) sector	250,80
Other		107,40
Olomouc Region		**Number of pieces in thousands**
		Face masks
Healthcare sector	Bed medical facilities	1 156,53
	Ambulance	73,45
	Outpatient sector	842,78
Social services	Bed facilities established by region	412,20
	Bed facilities not stablished by region	250,10
	Field (outpatient) sector	78,70
Other		217,05
Prague - the Capital		**Number of pieces in thousands**
		Face masks
Healthcare sector	Bed medical facilities	140,00
	Ambulance	16,00
	Outpatient sector	608,65
Social services	Bed facilities established by region	77,40
	Bed facilities not stablished by region	92,50
	Field (outpatient) sector	1 530,00
Other:Pharmacies + security department		
South Moravian Region		**Number of pieces in thousands**
		Face masks
Healthcare sector	Bed medical facilities	1 327,80
	Ambulance	166,75
	Outpatient sector	1 607,56
Social services	Bed facilities established by region	223,42
	Bed facilities not stablished by region	263,26
	Field (outpatient) sector	219,51
Other		803,51
Hradec Králové Region		**Number of pieces in thousands**
		Face masks
Healthcare sector	Bed medical facilities	403,22

	Ambulance	125,20
	Outpatient sector	670,05
Social services	Bed facilities established by region	211,25
	Bed facilities not stablished by region	146,35
	Field (outpatient) sector	122,60
Other		
Karlovy Vary Region		**Number of pieces in thousands**
		Face masks
Healthcare sector	Bed medical facilities	202,20
	Ambulance	3,89
	Outpatient sector	454,80
Social services	Bed facilities established by region	167,74
	Bed facilities not stablished by region	134,56
	Field (outpatient) sector	104,45
Other		51,51
Usti Region		**Number of pieces in thousands**
		Face masks
Healthcare sector	Bed medical facilities	1 146,25
	Ambulance	67,65
	Outpatient sector	977,60
Social services	Bed facilities established by region	219,80
	Bed facilities not stablished by region	468,25
	Field (outpatient) sector	261,10
Other		611,17
Vysocina Region		**Number of pieces in thousands**
		Face masks
Healthcare sector	Bed medical facilities	840,40
	Ambulance	39,35
	Outpatient sector	256,80
Social services	Bed facilities established by region	153,76
	Bed facilities not stablished by region	97,66
	Field (outpatient) sector	111,96
Other		969,38
South Bohemian Region		**Number of pieces in thousands**
		Face masks
Healthcare sector	Bed medical facilities	895,04
	Ambulance	118,26
	Outpatient sector	1 396,40
Social services	Bed facilities established by region	72,02
	Bed facilities not stablished by region	109,28
	Field (outpatient) sector	72,82

Other		
Pardubice Region		**Number of pieces in thousands**
		Face masks
Healthcare sector	Bed medical facilities	660,20
	Ambulance	36,90
	Outpatient sector	670,20
Social services	Bed facilities established by region	106,50
	Bed facilities not stablished by region	203,50
	Field (outpatient) sector	95,00
Other		388,20
Plzen Region		**Number of pieces in thousands**
		Face masks
Healthcare sector	Bed medical facilities	876,60
	Ambulance	58,80
	Outpatient sector	390,30
Social services	Bed facilities established by region	118,69
	Bed facilities not stablished by region	225,62
	Field (outpatient) sector	120,61
Other		

Tab. 2 : Distribution of protective medical face to regions of the Czech Republic (as of 12th **May 2020**) (9)

3.2. Use of the textile community face masks in Czech Republic during COVID-19 pandemic

As the COVID-19 outbreak expanded globally from beginning of year 2020, the supply chains for face masks (as well as for other PPEs) continued globally to be stresses by increased demand exceeding available supplies which resulted in shortages at public sectors (healthcare, social service, emergency services) as well as at the common market for public.

As already mentioned in chapter 3.2., during the emergency state in Czech Republic use of the face masks by all citizens was obligatory from 19th March 2020. Because of the lack of the the disposable face masks in Czech Republic at the beginning of the covid-19 pandemic, the single-use medical masks purchased by Czech Ministry of Interior were supplied exclusivelly to healthcare, social services and emergency sectors.

To be compliant with the obligations according to the government action, the Czech citizens proactively started to sew the community face masks from textile fabrics (100% cotton strongly preferred) at home. There were also many volunteers' initiatives sewing and distributing the home-made textile masks to other people, homes for elderly people, social services etc., followe by numerous textile manufacturers who started to produce the textile face masks.

With respect to that, majority of citizens in Czech Republic used the washable textile face masks; during the emergency state, the citizens used practically exclusively the textile face

masks and only very limited amount of disposable face masks was available for public. The availability of the single-use masks on the public market was gioing to be better approximately in end on May. But the price of the disposable face masks is quite high: the average price in shops is about 30 CZK/pc, in on-line e-shops about 10 CZK/pc (excluding transport fee). As the experts recommend to change the face mask max. after 4 hours of use, the price for total consumption would be very high. Assuming that citizens needed about 15,000,000 disposable face masks per day (3 disposable face masks for 5,000,000 people per day), then 735,000,000 disposable face masks would be needed in the period from March 15 to May 17, 2020 (during "State of Emergency"). As mentioned above, most of this need was covered by using textile face masks (made and paid by citizens), it means that they saved more than CZK 7,350,000,000 (if we calculate the price of the disposabel face mask about 10 CZK) - the amount was saved from state budget, because during "State of Emergency" just Government could buy and distribute disposabel face masks. Taking all these circumstances into account, the prevailing majority of people preffer use of textile face masks which are washable and repeatedly usable.

3.3. Use of face masks from the waste generation point of view

3.3.1. Disposable single-use masks

Bellow is the weight of the materials used in disposable medical face mask with a layer from nanofibers: (14)

spunbond/nano	*100% PP 17 g/m^2 + meltblown + nano PVDF 23g/m^2*	*format 0,18 x 0,18 m*
spunbond	*100% PP 23 g/m^2*	*format 0,205 x 0,18 m*
ties	*100% PP 40 g/m^2*	*format 0,02 x 1,74 m*
forming wire	*PP binding tape + iron wire*	*format 0,125 m*

The total weight of the face mask with ties .... 3,81 g
Weight of the of a separate mask body .... 2,4 g

At the end of March 2020, the estimated consumption of the disposable face masks in Czech Republic was 20 million per week according to Czech Interior Minister Jan Hamáček (11, 12); as the supplies were distributed almost exclusivelly into the public sector (healthcare, social services, emergency services), this ammount was dispposed as waste after the use. Taking into account the weight of the mask (3,81 g), it means production about 304,8 tonnes of the waste per month.

In July 2020 it was estimated, that the consumption of the face masks has increased hundredfold during the COVID-19 outbreak, from two million to 200 million per month according to TV NOVA television; so we can assume the monthly production about 762 tonnes of the waste from disposable face masks. (10)

Use of the face masks was mandatory in Czech Republic from 19th March till 25th May (partially), completelly till 15th June 2020. With increasing number of the new COVID-19 cases in summer 2020, the obligatory use of the face masks is again requested in some local hotspots in Czech Republic. According to experts´recommendation, the disposable mask should be replaced by the new one after 2-4 hours. When consuming e.g. two disposable face masks a day, one person would dispose 60 pieces per month; assuming that these would be used by only half of the Czech population, it is 300.000.000 pieces per month disposed as 1.143 tonnes of waste! (13)

3.3.2. Contribution of using "Fresh Dye" textile face masks to reducing the amount of waste generated

As already mentioned in the chapter 3.4., mandatory wearing of the face masks was declared by government decree from 19th March 2020 but at the beginning of the COVID-19 pandemic situation, there was a lack of the disposable face masks in Czech Republic. To be compliant with the obligations according to the government action, the Czech citizens proactively started to sew the face masks from textile fabrics (100% cotton strongly preferred) at home. There were also many volunteers initiatives sewing and distributing the home-made textile masks to other people, homes for elderly people, social services etc. Thanks to that, majority of citizens in Czech Republic used the washable textile face masks.

The standard textile face masks act only as a mechanical barrier to prevent spreading of infection from wearer. INOTEX in cooperation with external partners has developed the textile fabric with special treatment which is used for production of the textile face masks **„FreshDye".** These masks work on principle of the photoactive dyestuff which after irradiation with common daylight generates the short-term reactive forms of oxygen; thanks to that, the mask is protected against the pollutants including aproved antibacterial effect. The virucidal effect is expected as well; but due to the full occupied testing capacities of laboratories, testing of the virucidal effect of this fabric is not planned until November 2020.

Thanks to that effects, it is not necessary to wash the masks at 100°C to decontaminate them; textile can be washed at 60°C. Thanks to that, the service life of the fabric is significantly longer (as demonstrated at Fig. 2). The approved durability of the photocatalytic effect is at minimum 50 washing cycles but is expected to be significantly longer; this all prologs the service life in comparsion to "standard" 100% cotton masks (made form common fabric) and significantly reduces the amount of waste compared to disposable masks as well as to textile masks from 100% cotton without this special photocatalytic dyeing.

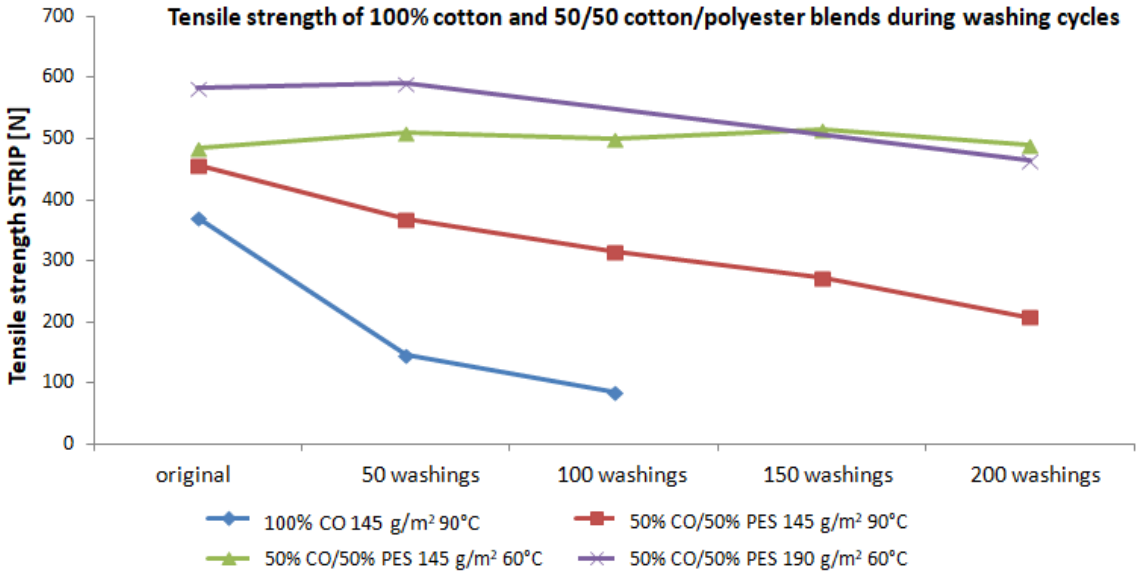

Fig. 2: Comparison of tensile strength of 100% cotton and 50/50 cotton/polyester blends during washing cycles at 90°c and 60°C (18)

As described also in deliverable D.*T2.3.3_Pilot Cases Technical Report_INOTEX medical devices covid-19*, two types of textile fabric were used for manufacturing of the "FreshDye" face masks during the COVID-19 emergency state in March-May 2020: 100% cotton (120 g/m^2) or blend cotton/PES 50/50 (140 g/m^2). The amount of 1.000 running meters of the "FreshDye" fabric is sufficient for manufacturing of 40.000 pcs of face masks (fabric width 160 cm) or 50.000 pcs (fabric width 180 cm). The face mask is made from two layers of textile; the outer layer is made from photocatalytic "FresDye" fabric, the inner is made from common textile (use of the photocatalytic textile for inner layer does not make sense because it is not enlightened with light).

As mentioned in deliverable D.*T2.3.3_Pilot Cases Technical Report_INOTEX medical devices covid-19*, the "FreshDye" face mask can be used during the whole day and it is not necessary to change it after 2-4 hours when it is damp; the moisture catalyzes the photocatalytic process and improves the self-cleaning function of the mask. As the minimum tested durability of the photocalatylic effect is 50 washing cycles, we can estimate that one person can use one "FreshDye" mask at minimum for 50 days. With respect to that, we can theoretically estimate that if the "FreshDye" face mask would be used by one half of the Czech population, the consumption would be 5.000.000 pieces/50 days with approved efficient self-cleaning effect. (In fact, these textile masks may be used much more longer till the material degradation as "common" textile face mask, even in a case that the photocatalytic functional dyeing would be not be fully efficient after so many washing cycles; durability of the photocatalytic effect after so more than 50 washing cycles was not tested.)

And as the used material is textile, the textile face mask can be recycled at the end of its service life.

FreshDye" face mask (estimated: outer layer – photocatalytic textile "FreshDye", inner layer – "common" textile with the same material composition and basis weight)

50.000 pcs: 1.000 running meters of fabric, width 180 cm … 1.800 m^2

100% cotton (2 layers, 120 g/m^2) … 432 kgs / min. 50 days

cotton/PES 50/50 (2 layers, 140 g/m^2) … 504 kgs / min. 50 days

Fig. 3 : "FreshDye" face mask

3.3.3. THE DEMONSTRATION EXAMPLE

Comparison of the different material types of face masks from the waste generation point of view

In this example we would like to demonstrate the positive effect of use of the textile "FreshDye" face mask on volume of the produced waste. (the input data – see chapter 3.3 and 3.4)

- Hypothetical consumption of disposable masks in CZ during mandatory wearing period

  (one half of CZ population) 300.000.000 pcs/month

  1.143 tonnes/month

- "FreshDye" face mask (outer layer – photocatalytic textile "FreshDye", inner layer "common" textile with the same material composition and basis weight)

  50.000 pcs: 100% cotton (2 layers, 120 g/m^2) ... 432 kgs / min. 50 days

  cotton/PES 50/50 (2 layers, 140 g/m^2) ... 504 kgs / min. 50 days

	Disposable face masks		"FreshDye" face masks	
	Consumption / 50 days [pcs]	Generated waste / 50 days [tonns]	Consumption / 50 days [pcs]	Generated waste / 50 days [tonns]
Hypothetical consumption of one half of CZ population (5.000.000 people)	500.000.000	1.905 *)	5.000.000	100% cotton (120 g/m^2) ... 43,2 co/PES 50/50 (140 g/m^2) ... 50,4
	Disposed as waste		Recyclable textiles	
*) estimated weight of the disposable face mask 3,81 g/pc (14)				

3.4. Overview of the Czech manufacturers of face masks according to the production capacity

Remark:
Unless otherwise stated, masks are not certified for healthcare.

Data valid as of 12.5.2020
Source: ATOK (1)

PRODUCTION CAPACITY 0 – 999 pcs / week

Manufacturer	Web	Description and material composition	Mask type (washable / disposable)
Arimo, spol. s r.o.	www.arimo.cz	double folded textile mask with ties / cotton canvas	washable
H&D, a.s.	www.hd-nabytek.cz	disposable medical 93/42 / EEC	disposable
Českomoravská textilní s.ro.	www.adwin-products.com	Textile, non-woven textile	washable as well as disposable
České filtry s.r.o.	www.ceskefiltry.cz	non-woven textile	disposable
Vestimentum spol s.r.o.	jan.podlipny@blazek.cz	non-woven textile	disposable
MODELA, v. d. Pardubice	www.modelapardubice.cz	textile masks for repeated use /100% cotton	washable

PRODUCTION CAPACITY 1 000 – 2 499 pcs / week

Manufacturer	Web	Description and material composition	Mask type (washable / disposable)

CAPPA 2, s.r.o.	www.cappa.cz	100% cotton	washable
KNITVA s.r.o.	www.knitva.cz	with the possibility of inserting an effective filter / 100% cotton, 100% antibacterial cotton	washable
družstvo TEXman	www.texman.cz	textile double-layer surgical mask - handmade in standard sewing workshop	washable
družstvo TEXman	www.texman.cz	textile double-layered surgical mask with insert filter - handmade in standard sewing workshop	washable
ORTO plus, s.r.o.	www.ortoplus.cz	various types of face masks with a nose fitting: women's, men's, children's; for rubber band of various lengths (suitable for quick deployment); for strings (suitable for all-day wear); 100% cotton; with pocket for inserting a filter; shaped or folded; menu of filters to insert	washable
Matlocha s.r.o.	www.matsport.cz	3 types / cotton	washable
Veratex Česká republika s.r.o.	www.veratex.cz	100% cotton	washable
FOMI PRO s.r.o.	www.fomipro.cz	100% cotton or 50% cotton/50% PES	washable
RITMO v.o.s.	www.ritmo.vyrobce.cz	100% cotton	washable
Milan, spol. s r.o.	www.milan.cz	folded single-layered for binding 100% cotton	washable
Airtex styl s.r.o.	www.gravirovani-rezani.cz	double-layer mask / 100% cotton	washable
ARCACZECH s.r.o.	www.arcaczech.cz	100% cotton, 100-150 g/m^2	washable
Vestimentum spol s.r.o.	jan.podlipny@blazek.cz	100% cotton	washable
FIM s.r.o.	www.fim-sehradice.com	textile	washable

PRODUCTION CAPACITY 2 500 - 4 999 pcs / week

Manufacturer	Web	Description and material composition	Mask type (washable / disposable)
Ing. Lubomír Horký - LUIZ s.r.o.	www.luiz.cz	double-layered folded / 100% cotton, possibly also made of antibacterial cloth with zinc additive made of certified substance	washable
DAVÍDEK s.r.o.	www.davidek.cz	100% cotton, percale, double layer with pocket (even without) for filter	washable
K A M A spol. s r.o.	www.kama.cz	cotton	washable
ELITE a.s.	www.elite-cz.cz	double-layered with pocket, 100% cotton	washable
družstvo TEXman	www.texman.cz	textile mask of nanomaterial - L (disposable) - handmade in standard sewing workshop	disposable
GUMOTEX coating, s.r.o.	www.gumotex.cz	cotton masks, double-layer	washable
Drupo,výrobní družstvo	www.drupo.cz	100% cotton	washable
Arikos s.r.o.	www.arikos.cz	100% cotton	washable
Clemente s r.o.	daniela.mirzova@clemente.cz	cotton with antibacterial treatment	washable
blazek stick & caps s.r.o.	www.ksiltovky.cz	cotton	washable
Veškrna Květoslav	kvetoslav.veskrna@seznam.cz 1	100% cotton	washable
Oděva v.d. Třebíč	www.odevatrebic.cz	single and multi-layered with a pocket, 100% cotton or blended	washable

		material	
APPLYCON s.r.o.	www.applycon.cz	textile masks, cotton or Coolmax	washable
Gamsbart s.r.o.	ilonakanakova@seznam.cz	cotton	washable
CARATTI elastic textiles, s.r.o.	www.caratti.cz	knitt, woven fabric	washable
Brotex Z&J s.r.o.	www.brotex.cz	cotton masks double-layered for binding / 100% cotton / two types possible: without pocket or with pocket for filter	washable
Styl - Plzeň	www.styl-plzen.cz	100% cotton - the company employs more than 50% of health disabled fellow citizens	washable

PRODUCTION CAPACITY 5 000 - 7 499 pcs / week

Manufacturer	Web	Description and material composition	Mask type (washable / disposable)
Aksana, s.r.o.	www.aksana.cz	100% cotton with antibacterial and hydrophobic finishing - www.castellonhatscaps.eu/rousky-na-usta	washable
Linia s.r.o.	www.linia.cz	Double-layered with a pocket for filter or without; for tighting; folded; 100% cotton	washable
František Kotásek	www.kotasekodevy.cz	100% cotton	washable
VEBA, textilní závody a. s.	www.veba.cz	cotton mask with lace	washable
Fashion MiPlus, s.r.o.	lenkapluskalova@seznam.cz	100% cotton, double-layered or according to requests	washable
FALKO FaL s.r.o.	www.falkofal.cz	textile mask, washable / cotton	washable
FALKO FaL s.r.o.	www.falkofal.cz	disposable mask / non-woven + pulp	disposable
Mars a.s.	www.marsjev.cz	folded mask / cotton	washable
Yvetta Böhmová	www.pramont.eu	masks / cotton	washable
Lamido, a.s.	www.lamido.cz	100% cotton, weight 250 g / m2 - sheltered workshop, the possibility of substitute performance	washable
INVAZ s.r.o.	www.invaz.cz	face mask / cotton woven cloth with carbon insert	washable
MODETA STYLE s.r.o.	www.modetastyle.cz	two-layer in five versions / fabric 100% cotton / includes melblown filter insert FFP1 // single-layer in five versions / fabric 100% cotton	washable
DUP - družstvo	eshop.dup.cz/rousky	Outer material pre-washed undyed cotton, inner filter material in two layers PP Meltblown Polypropylene 100%, 50 gsm, assuming an efficiency of about 80% (efficiency of one layer as measured at the Technical University of Liberec at the Institute of New Technologies and Applied Informatics: "The sample of one layer shows an efficiency for particles of 0.6 micrometer 38%	washable

		(it is efficiency estimate according to EN standard 143). Due to the pressure drop, this material could be used as a material for medical masks.	
RTK, spol. s r.o.	www.rtksro.cz	cotton mask	washable
družstvo TEXman	www.texman.cz	textile mask of nanomaterial - S (disposable) - handmade in standard sewing workshop	disposable
Petr Král	www.mpkral.cz	100% cotton	washable
OK Textil s.r.o.	www.ok-textil.cz	cotton	washable
www.capu.cz	www.capu.cz	mask; cotton	washable
Direct Alpine s.r.o.	www.directalpine.cz	folded mask with filter pocket - possibility to supply insert filters made of filter fabric / 100% cotton	washable
HIPPOinvest Development a.s.	www.deky-polastare.cz	single and double-layered masks, cotton with pocket with nanofilter / 100% cotton	washable
SPOLTEX Kravaře s.r.o	www.spoltex-kravare.cz	single jersey 100% Cotton, ÖKO-TEX 100 STANDARD Certificate, (two-layered), 145 gr / m2	washable

PRODUCTION CAPACITY 7 500 - 9 999 pcs / week

Manufacturer	Web	Description and material composition	Mask type (washable / disposable)
H&D, a.s.	www.hd-nabytek.cz	sewn 5 layers - linen + 4 layers NW PP	disposable
H&D, a.s.	www.hd-nabytek.cz	sewn 2 layers - linen + cotton	washable
fashion IREA s.r.o.	www.odevy-irea.cz	100% cotton	washable
DaniDarx, s.r.o.	www.styx-underwear.cz	100% cotton	washable
TEXTIL Kubíček, s.r.o.	www.kubicektextil.cz	cotton / polyester	washable

PRODUCTION CAPACITY 10 000 - 14 999 pcs / week

Manufacturer	Web	Description and material composition	Mask type (washable / disposable)
VKUS, v.o.d. Klatovy	www.vkuskt.cz	single folded / cotton	washable
SHELTMEN s.r.o.	www.bandaze.eu	cotton	washable
2G-spol. s r.o. - Přikrývky a polštáře	www.2g.eu; www.2glipov.cz	cotton mask with nanomembrane filter (polyamide)	washable
2G-spol. s r.o. - Přikrývky a polštáře	www.2g.eu; www.2glipov.cz	cotton masks treated with solution with silver ions	washable
2G-spol. s r.o. - Přikrývky a polštáře	www.2g.eu; www.2glipov.cz	cotton mask with the possibility of inserting a nanomembrane filter	washable
Jitex COMFORT s.r.o.	www.jitex-comfort.cz	double-layered - it is possible to insert filter / 100% cotton in weight 130 - 150 g / m2 can be inserted - one-face knit	washable
Jitex COMFORT s.r.o.	www.jitex-comfort.cz	protective mouth three-layer mask / nonwoven fabric with nanofiber membrane	disposable

JANEK spol. s r.o.	www.janek.cz	100% cotton without and with antibacterial finishing	washable
Kubák, tkalcovna Strmilov, k.s.	www.tkalcovna.cz	cotton	washable
Moravská ústředna Brno, družstvo umělecké výroby	www.mubrno.cz	100% cotton	washable
LIPTEX Trading s.r.o.	www.liptex.cz	type R1- with 3 folds, rubber band behind the ears / 100% cotton masks with antibacterial treatment - supplier of material Mileta a.s., masks are 2-layered with a aperture for inserting a filter	washable
LIPTEX Trading s.r.o.	www.liptex.cz	type R2- smooth, woven with a fabric behind the head / 100% cotton masks with antibacterial treatment - supplier of material Mileta a.s., masks are 2-layered with a aperture for inserting a filter	washable
OD Vývoj Třešť	www.vyvoj.cz	SMS 47g medical material	disposable
OD Vývoj Třešť	www.vyvoj.cz	100% cotton	washable
Výrobní družstvo VKUS Frýdek-Místek	www.vkusfm.cz	double layer folded drape / 100% cotton (canvas)	washable
KOFTEX s.r.o.	www.koftex.cz	100% cotton	washable
Sněžka, výrobní družstvo Náchod Jugoslávská 260, 547	www.snezka-na.eu	100% cotton	washable
Techtex s.r.o.	www.techtex.cz	masks / cotton	washable
KVIS B+S s.r.o.	www.kvis.eu	Single-faced knit 180 g/m2, 100% cotton canvas	washable
ARBIS, spol. s r.o.	www.arbis.cz	R-SKL-2 mask folded single-layered, binding on the top of the head and behind the neck, woven fabric 100% cotton, edging elastic polyamide / elastane	washable
ARBIS, spol. s r.o.	www.arbis.cz	R-MA-1 mask two-layered, behind the ears, eoven fabric 100% cotton, edging elastic polyamide / elastane	washable
LUKO, s. r. o.	www.lukock.cz	100% nanofiber Tencel, 100% cotton and others	washable
OVAG s.r.o.	www.ovag.cz	100% cotton, square folded with 4 laces	washable
Vodenka s.r.o	www.odevyvodenka.cz	100% cotton	washable

PRODUCTION CAPACITY 15 000 – 24 999 pcs / week

Manufacturer	Web	Description and material composition	Mask type (washable / disposable)
Tex Trading Cavaliere, s.r.o.	www.cavaliere.se	100% cotton	washable
PUMAX spol. s.r.o.	www.pumax.cz	Knitted, seamless mask made of man-made functional fibers with silver (reusable, washable at 90°C. A 3D knitted fabric which - in contrast to the cotton masks - does not release fibers and is gentle to the respiratory system. It has great breathability. The premium	washable

		material is also used for functional underwear and is intended for direct contact with skin. The used polypropylene is enriched with a biocidal component – phosphate glass with silver (CAS 308069-39-8)).	
BeWooden Company s.r.o.	www.bewooden.cz	Double-layered cotton masks with twine or rubber band and pocket for filter "accordion type" + we can supply also a special NANO filters for replacement.	washable
BeWooden Company s.r.o.	www.bewooden.cz	Medical masks with material certification ČSN EN 13795+A1	disposable
NET CZ s.r.o.	smetana@net-cz.cz	cotton	washable
Dita výrobní družstvo invalidů	www.dita.cz	single-layered, double-layered of with filter, various cuts / 100% cotton	washable
Moděva oděvní družstvo Konice	www.modeva.cz	cotton mask double-layered with replaceable filters	washable
Martin Průša, PAMS	www.pams.cz; www.pams.eu;	cotton textile masks	washable
Novitex Fashion a.s.	www.novitex.cz	cotton washable mask with replaceable nanofilter with a filtration efficiency of more than 99% (tested in Nelson Labs USA), supplied in sterilized sets	washable
LaLinea s.r.o.	www.textil.eu	100% cotton, with antibacterial and hydrophobic finishing	washable
Neumanna s.r.o	www.neumanna.cz	Orion Fresh Dye – antibacterial finishing – source Inotex / 100% cotton	washable

PRODUCTION CAPACITY 25 000 – 49 999 pcs / week

Manufacturer	Web	Description and material composition	Mask type (washable / disposable)
HIKOSPORT s.r.o.	www.hiko.cz	100% cotton, with pocket for filter	washable
Otavan Třeboň a.s.	www.otavan.cz	100% cotton, cotton blend, nanotextile	washable
EL DIN Fashion	info@eldin-fashion.cz	NANO material or cotton with antibacterial finishing or with admixture of silver	washable and disposable
VAVI s.r.o.	www.vavi.cz	100% cotton (silver plus) + pressed insert inside (3-layered mask)	washable
LIPOELASTIC a.s.	www.lipoelastic.cz; www.eshop.lipo	Single layered on laces in white or dark blue in size 19,5x8 cm / 98% cotton, 2% elastane, weight 195 g/m^2	washable

PRODUCTION CAPACITY 50 000 – 74 999 pcs / week

Manufacturer	Web	Description and material composition	Mask type (washable / disposable)
CLINITEX	www.clinitex.cz	Textile masks (according to ČSN EN	washable

		13795+A1) for repeated use	
SVITAP J.H.J. s.r.o.	www.svitap.cz	100%, rubber band	washable
EVONA a.s.	www.evona.cz	cotton	washable
EVONA a.s.	www.evona.cz	FFP2 / POP (equivalent to NANO)	disposable
RUTEX CZ,s.r.o.	www.rutexcz.cz	100% cotton - OEKO-TEX STANDARD 100 for class , it has antibacterial and antifungal treatment confirmed by certificate	washable
Retex a.s.	www.retex.cz; www.rouskyretex.cz	2 types of masks / 70 % polypropylene, 30 % polypropylene with content of silver	washable

PRODUCTION CAPACITY 75 000 - 99 999 pcs / week

Manufacturer	Web	Description and material composition	Mask type (washable / disposable)
ROLSIT s.r.o.	www.rolsit.cz	organic cotton fabric with GOTS certificate and Oekotex class I	washable
Dina-Hitex	www.dina-hitex.com	three-layered face mask with a rubber band	washable
ARCÁDE COLOR s.r.o.	www.arcadecolor.cz	100% cotton with a treatment for bacterial capture of 99,9% (higher hygiene and freshness, tested by ASTM - E 2149-01, 100 guaranteed washing cycles at temperature 95 °C)	washable

PRODUCTION CAPACITY 100 000 - 999 999 pcs / week

Manufacturer	Web	Description and material composition	Mask type (washable / disposable)
Snaha a.s.	www.snaha.cz	100% cotton + filter from nanomaterial	washable
BW General s.r.o.	www.snaha.cz	100% cotton + filter from nanomaterial	washable
Dina-Hitex	www.dina-hitex.com	three-layered with ties	washable
Mileta a.s.	www.mileta.cz	cotton, cotton/PES, antibacterial, hydrophobic, own production of textiles	washable
Odbytové družstvo eBIOneta	www.ebioneta.net	NTF with filter FFP2	disposable
Svitap J.H.J. spol. s r.o.	www.svitap.cz	binding mask 100% medical cotton, Oekotex certificate (supplied in a PE bag and then in paper box 25 pieces each 1 package)	washable
Svitap J.H.J. spol. s r.o.	www.svitap.cz	mask with rubber bands 100% medical cotton, Oekotex certificate (supplied in a PE bag and then in paper box 25 pieces each 1 package)	washable

4. Bibliography

(1) e-ATOK Revue 5/2020. Association of Textile-Clothing-Leather Industry. May 2020. http://www.atok.cz/folders/revue/2020/e-ATOK_Revue-2020-05.pdf

(2) https://www.mzp.cz/cz/news_20200402-MZP-zverejnilo-doporuceni-jak-nakladat-s-pouzitymi-ochrannymi-pomuckami-na-pracovistich

(3) http://www.szu.cz/uploads/Epidemiologie/Coronavirus/Odpady/D_Nakladani_s_komunalnimi_odpady_v_obcich_1_.pdf

(4) Metodika pro nakládání s odpady ze zdravotnických, veterinárních a jim podobných zařízení. (Methodology for waste management from medical, veterinary and similar facilities.). SZÚ, 2016. https://www.mzp.cz/C1257458002F0DC7/cz/nakladani_s_odpady_zdravotnictvi/$FILE/OODP-metodika_zdravotnicke_odpady-20170424.pdf

(5) http://www.szu.cz/uploads/documents/chzp/puda/legislativa_odpady/MD_odpady_zdravotnictvi.pdf

(6) https://www.polarismarketresearch.com/industry-analysis/face-mask-market

(7) Respiratory Protective Equipment - Global Market Outlook (2018-2027). Research and markets. May 2020, ID: 5050693. https://www.researchandmarkets.com/reports/5050693/respiratory-protective-equipment-global-market?utm_source=MC&utm_medium=Email&utm_code=mzri6rvsq&utm_ss=44&utm_campaign=1407310+-+Respiratory+Protective+Equipment+-+Global+Market+Outlook+(2018-2027)&utm_exec=iare121mtd

(8) Face Mask Market - Global Outlook and Forecast 2020-2025. Research and Markets, July 2020. ID: 5130174. https://www.researchandmarkets.com/reports/5130174/face-mask-market-global-outlook-and-forecast?utm_source=BW&utm_medium=PressRelease&utm_code=sn84gv&utm_campaign=1417321+-+Global+Face+Mask+Market+-+Outlook+and+Forecast+2020-2025+with+the+Projected+Impact+of+COVID-19&utm_exec=joca220prd

(9) https://www.mvcr.cz/clanek/nakup-a-distribuce-ochrannych-prostredku-za-mv.aspx

(10) https://tn.nova.cz/clanek/v-cesku-prudce-stoupla-spotreba-rousek-podivejte-se-jak-se-vyrabi.html

(11) https://www.piratskelisty.cz/clanek-3035-poslanec-tomas-martinek-kolik-rousek-a-jinych-ochrannych-pomucek-zvladnou-vyrobit-ceske-firmy

(12) https://twitter.com/jhamacek/status/1244016623348056064

(13) https://www.spolecenskaodpovednost.cz/chirurgicke-rousky-jako-zdroj-infekce-a-zbytecneho-odpadu/

(14) BATIST medical a.s.

(15) https://www.trideniodpadu.cz/zdravotnicky-odpad

(16) Metodické doporučení SZÚ pro hodnocení účinnosti dekontaminace odpadů ze zdravotnictví, SZÚ, Acta hygienica, epidemiologica et microbiologica č. 1/2010 http://www.szu.cz/uploads/documents/knihovna_SVI/pdf/2010/full_2010_01.pdf

(17) INOTEX - project MECTEX (FR-TI3/466, Ministry of Industry, Czech Rep., 2011-2014)