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Health, socio-economic and environmental aspects of possible amendments to the EU Directive on the protection of workers from the risks related to exposure to carcinogens and mutagens at work

4,4'-Methylene bis 2-choloraniline (MbOCA)

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SUMMARY

4,4'-methylene bis 2-chloroaniline (MbOCA) been classified by the International Agency for Research on Cancer (IARC) as carcinogenic to humans based on limited human epidemiological data and other evidence that it may cause bladder tumours. Under the classification and labelling legislation in Europe it is classified as a Cat 2 carcinogen and they are therefore within the scope of the EU Carcinogens Directive. However, there is no occupational exposure limit (OEL) for MbOCA specified in the Directive.

Exposure to MbOCA is primarily by skin uptake and so in this report we focus on biological monitoring data rather than inhalation exposure. This report considers the likely health, socioeconomic and environmental impacts associated with possible changes to the Carcinogens Directive, in particular the possible introduction of a limit value equivalent to a biological monitoring guidance value (BMGV) of either 5 and 15 µmol/mol.

MbOCA is an aromatic amine used as a curing agent in epoxy resins and mixed with isocyanate based resins to produce polyurethanes and elastomers. It is widely used in the rubber and plastic industries. It is not manufactured in the European Union (EU) countries and is supplied as pellets, granules or liquid form. It is estimated that approximately 2,500 workers in the EU are potentially exposed to MbOCA, of which about 1,400 are estimated to be potentially exposed in high exposure industries (manufacture of rubber and plastic products). Average exposure levels are probably about 2.3 µmol/mol with a geometric standard deviation of 5. This implies that currently about 16% of exposures are above 5 µmol/mol and about 5% above 15 µmol/mol. It is likely that average MbOCA exposures have been decreasing by about 7.9% per annum.

We estimate that in 2010 in the EU there will be about 3 deaths (eight registrations) from bladder cancer that might be attributable to past exposure to MbOCA, which corresponds to about 0.006% of all bladder cancer deaths and a loss of 39 Disability-Adjusted Life Years (DALYs). In the absence of any intervention the health burden is predicted to drop steadily over the next 50 years.

The main costs associated with inaction occur in the period 2010-2040, and these are predominately the result of past exposure. It is estimated that in total over the next 60 years there will be between €45m and €353m of health costs if no limit value is introduced, with the highest costs falling on Germany, France, Italy, the UK and Poland.

It is judged that compliance with a BMGV of 15 µmol/mol could be achieved with no important cost implications through improved training and supervision. By 2060 it is predicted the attributable cancer deaths with this limit would be less than one per annum (based on <1 registration). It is estimated there will be two DALYs vs four DALYs for the baseline scenario. Compliance with a limit of 5 µmol/mol would result in less than one attributable cancer registration and death by 2060 (zero DALYs by 2060). The health benefits over the period 2010 to 2069 are expected to be between €1m and €7m for the 15 µmol/mol limit and between €1m and €11m for the 5 µmol/mol limit. Corresponding cost of compliance over the same period are estimated as between €564m and €1,129m for the higher limit and between €1,482m and €2,964m for the lower limit.

It are not expected that there will be any important social, macro-economic or environmental impacts.



1 PROBLEM DEFINITION

1.1 OUTLINE OF THE INVESTIGATION

Based on the available epidemiological literature, toxicology and other information there is concern that 4,4'-methylene bis 2-chloroaniline (MbOCA) may cause bladder cancer. Exposure to MbOCA has been classified as a group 1 (Carcinogenic to humans) carcinogen by IARC and as Cat 2 carcinogens in the EU under the classification and labelling legislation¹. MbOCA is therefore already regulated as a carcinogen throughout the EU. In this assessment we consider the impacts of introducing an exposure limit for MbOCA within the EU Carcinogens and Mutagens Directive.

The key objectives of the present study are to identify the technical feasibility and the socioeconomic, health and environmental impacts of introducing a regulatory exposure limit for MbOCA of 0.1 mg/m^3 (considered broadly equivalent to a biological monitoring limit value between about 5 and 15 μ mol/mol).

1.2 OELS/EXPOSURE CONTROL

Existing national OELs (Occupational Exposure Limits) in EU member states are presented in Table 1.1. These are expressed as long-term limits, averaged over an 8-hour working day or short–term exposure limits (STELs), i.e. 15 minutes. OELs from selected countries outside the EU are also presented for comparison.

Table 1.1 Occupational Exposure Limits in Various Member States and selected countries outside the EU

Country	OEL – long-term	OEL - STEL
•	(mg/m ³)	(mg/m ³)
Austria	0.02	0.08
Belgium	0.11	
Denmark	0.11	0.22
France	0.22	
The Netherlands	0.02	
Spain	0.1	
United Kingdom	0.005	
Canada – Quebec	0.22	
Japan	0.005	
Switzerland	0.02	
USA – NIOSH	0.003	

Source: http://www.dguv.de/bgia/en/gestis/limit_values/index.jsp

There were no identified occupational limits for the majority of the EU member states. For those member states for which there where OELs, the long-term OEL range from 0.005 mg/m³ to 0.22 mg/m². For the purposes of this report OELs of 0.1 mg/m³ and above are considered typical for the EU.

However, since the dermal route of exposure it likely to be the main route of exposure, this limit is not considered to be particularly useful to control exposure. The UK Health

¹ Available at: http://monographs.iarc.fr/ENG/Classification/ClassificationsAlphaOrder.pdf



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and Safety Executive (HSE) have recommended that regular urine samples should be analysed from workers exposed to MbOCA². A biological monitoring guidance value based on the 90th percentile of exposures collected at the end of a shift was set at 15 µmol MbOCA/mol creatinine in urine in 1995 (Cocker *et al*, 2009). However, it is likely that if a limit was to be set in 2010, that this would now be around 5 µmol/mol (Cocker, personal communication). This is in agreement with the biological monitoring action limit of 5 µmol/mol set by the Finnish Institute of Occupational Health³.

It is suggested that a biological monitoring limit (BMGV), rather than an OEL be used as relevant and "typical" limit as a practical tool to assess compliance, and that the limit should be either 5 or 15 μ mol/mol.

1.3 DESCRIPTION OF DIFFERENT USES

4,4'-methylene bis 2-chloroaniline (MbOCA) is an aromatic amine which is used as a curing agent in epoxy resins and mixed with isocyanate based resins to produce polyurethanes and elastomers. It is widely used in the rubber and plastic industries. IARC has classified MbOCA as carcinogenic to humans (Group 1) based on inadequate evidence from human studies and sufficient evidence from experimental animal studies. It is associated with occupational asthma and chronic obstructive pulmonary disease. In its pure form it is a solid at room temperature and has low volatility. It is easily absorbed through the skin and the dermal route of exposure is the most important (McNally and Binch, 2007).

MbOCA is not manufactured in the European Union countries and is supplied as pellets, granules or liquid form. In the UK production stopped in 1987 and imports have increased from 90-120 tonnes in 1995 to more than 200 tonnes in 2006 (Cocker *et al*, 2009). In the UK, three companies import MbOCA for supply in the UK. In 2005, 25 UK companies used over 200 tonnes of MbOCA and 2000 tonnes of resin compared with 1984 when approximately 36 companies used 100 tonnes (HSE report, 2006). Suppliers of MbOCA typically do not handle MbOCA directly, but supply filled drums to the polyurethane industry as delivered by the manufacturer.

Handling of MbOCA during the production of polyurethane elastomers can be either manual or automatic. Manual methods of handling typically involve scooping MbOCA pellets from a keg into a container, weighing and heating to 98-110°C. This is then mixed with a liquid pre-polymer resin at 60-80°C, containing TDI or MDI. Colorants may also be added at this mixing stage. Weighing, melting and mixing are usually carried out under local exhaust ventilation. With automatic methods of handling, heating and mixing is carried out in a reactor vessel and the product automatically dispensed. Casting into moulds pre-heated to 90-95°C, curing in ovens at 100-120°C for 4-24 hours and finishing follow. There is potential for spillage and exposure during all process stages, particularly during scooping, weighing and pouring into moulds, even when automatic handling methods are used.

The European Tyre and Rubber Manufactures Association (ETRMA) report that MbOCA is still used in the General Rubber Goods (GRG) sector but for a specific application and in a very low quantity (personal communication from ETRMA). It can be used as a vulcanisation accelerator for the elastomer polyurethane.

³ Available at: http://www.ttl.fi/NR/rdonlyres/CC624487-8DDA-4C6C-91DC-B916104BCA47/0/BMGuideline20092010.pdf



² Available at: http://www.hse.gov.uk/pubns/msa21.htm

1.4 RISKS TO HUMAN HEALTH

1.4.1 Introduction

Bladder cancer is a relatively common cancer that is generally diagnosed in people over 60 years of age. There are about twice as many cases diagnosed in men compared to women. In the EU it comprises about 5% of all cancer incidence (Ferlay *et al*, 2007). Key environmental risk factors are cigarette smoking, some industrial chemicals, diet and genetic factors. Mortality amongst European men, especially younger men, has been dropping steadily since the mid-1970s, which is probably due to changes in smoking prevalence and reductions in occupational exposure to aromatic amines such as benzidine and α -and β -naphthylamine (Levi *et al*, 2004).

Early symptoms of bladder cancer include intermittent haematuria (blood in the urine), changes in the frequency of urination and pain when urinating, although all of these symptoms are also associated with other non-malignant conditions. About three quarters of people diagnosed with bladder cancer can be treated by relatively minor surgery (transurethral resection of superficial bladder cancer), with chemotherapy and/or immunotherapy, giving a relatively good prognosis. For more serious cases of bladder cancer (muscle invasive tumours) the treatment options include surgery, chemotherapy and radiotherapy. Survival rates are lower for these types of tumours.

1.4.2 Summary of the available epidemiological literature on risk

As part of a retrospective bladder cancer incidence study of workers exposed to MbOCA, 385 participated in a urine screening test (Ward *et al*, 1990). Exfoliative cytology revealed that the morning urine samples obtained from 21 workers contained atypical cells Urine samples obtained from 16 workers were positive for heme (Ward *et al* 1990). In the course of screening, one participant who was negative for cytology and heme impairment was diagnosed with bladder cancer. Cystoscopy was introduced as a part of the follow-up procedure, and two additional low-grade papillary tumours of the bladder were detected. Two of the men were less than 30 years old, an uncommon finding in a cancer that is usually found in older people.

A recent paper reports the case of a 52-year-old male chemical worker diagnosed with bladder cancer (Liu *et al*, 2005). He was a non-smoker and had worked for a company producing MbOCA, to which he had been exposed for 14 years in the purification plant. A cohort of 308 male production workers from 7 factories in the UK engaged in the manufacture of polyurethane elastomers using MbOCA has recently been defined (Dost *et al*, 2009). They were employed between 1973-2000. Overall mortality for all cancers was below that expected (5 deaths, standardised mortality ratio (SMR) 0.68, 95% confidence interval (CI) 0.19-1.74) and the incidence of all cancers was also low (standardised incidence ratio (SIR) 0.77 95% CI 35-147). There was one death from bladder cancer (SMR 5.60 95%CI 0.14, 31.22) and 2 cancer registrations (SIR 3.28, 95% CI 0.40,11.84).

1.4.3 Choice of risk estimates to assess health impact

MbOCA is suspected of being a human carcinogen because its chemical structure is similar to the known human bladder carcinogen benzidine, and to that of a potent animal carcinogen, 3,3'-dichlorobenzidine (Osorio et al 1990; Ward et al 1990). Based on the result for cancer registrations in the UK study by Dost et al (2009) a risk



estimate of 3.28 (95%CI 0.40-11.84) has been used for high exposure to MbOCA. A risk estimate of 1 has been used for the low group.

2 BASELINE SCENARIOS

2.1 STRUCTURE OF THE SECTOR

MbOCA is not manufactured in European Union countries and is supplied as pellets, granules or liquid form. However, no data is available on the quantities of MbOCA imported in to the EU. The current value of MbOCA/ tonne is not known. Production of MbOCA in the United States is reported to have ceased⁴. It is thought that MbOCA is produced in China although quantities are uncertain.

2.2 PREVALENCE OF Mboca exposure in the EU

The estimated exposure prevalence for the EU member states based on 2006 employment data is shown in Table 2.1. It is estimated that approximately 2,500 workers in the EU are potentially exposed to MbOCA, of which approximately 1,400 are estimated to be potentially exposed in high exposure industries (manufacture of rubber and plastic products).

The prevalence of exposure to MbOCA was estimated based on the Finnish CAREX estimate of 2007, The Spanish CAREX estimate of 2004 and the Italian CAREX estimate of 2000 – 2003 (Mirabelli and Kauppinen, 2005). The proportion of workers in each industry who are exposed was taken from each of these three CAREX estimates and the average proportion exposed across all three countries calculated for each industry.

The number of workers employed in each industry in 2006 was, where possible, obtained from the EUROSTAT database,5 which provides numbers exposed at the level of two or three digit NACE code. If information from 2006 was unavailable, it was substituted with information from 2005 or recorded as being unavailable. Where the numbers of workers employed is not available from the EUROSTAT database, this information was obtained from the Labour Force Survey (LFS). The LFS only provides information at NACE section level, which incorporates a number of two digit NACE codes. The number of exposed workers in each industry in each country, including Finland, Spain and Italy, was estimated by multiplying the number of workers employed in each industry in each country in 2006 by the average proportion of exposed workers. The estimated number of male and female employees in each industry group in each EU member state is also shown in Table 2.1. These estimates were obtained by applying the average male to female employee ratio for the industry group for each country to the total number of employees. Male to female employee ratios were calculated with data from the LFS. Managers, sales people and office clerks were excluded from these calculations as they were assumed to be unexposed.

⁵ Available at: http://epp.eurostat.ec.europa.eu/



⁴ Agency for Toxic Substances and Disease Registry (ATSDR) (1994) Toxicological Profile for 4,4'-methylenebis(2-chloroaniline) (MBOCA). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Table 2.1 Exposure prevalences by NACE code and country

					NACE c	ode				
		25		NA.	29	.ro of		73		
	Manu	facture (of rubber		Manufacture of machinery and other			Research and		
Country	and plastic products				uipment		equipment			
	_	Employ		_	Employ			Employe		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	
Austria	37	30	7	16	13	3	4	3	1	
Belgium	35	28	7	9	7	2	5	3	2	
Bulgaria	31	16	15	14	7	7	0	0	0	
Cyprus	2	1	0	0	0	0	1	Not availa	ble	
Czech Republic	110	72	39	33	21	11	5	3	2	
Denmark	27	20	7	13	9	3	5	3	2	
Estonia	7	4	3	1	1	1	0	0	0	
Finland	20	15	5	12	9	3	3	2	1	
France	301	231	69	61	47	14	33	22	11	
Germany	492	384	108	211	165	46	75	48	27	
Greece	15	12	4	5	3	1	7	4	3	
Hungary	53	34	20	14	9	5	5	3	2	
Ireland	13	10	3	2	2	1	2	1	1	
Italy	261	196	65	113	85	28	21	13	8	
Latvia	6	3	3	1	1	1	1	1	0	
Lithuania	12	6	6	2	1	1	1	0	0	
Luxembourg	8	7	1	0	0	0	1	Not availa	ble	
Malta	1	Not avail	able	Not ava	ailable		Not ava	ailable		
Netherlands	42	35	7	18	15	3	27	19	8	
Poland	196	131	65	41	28	14	3	2	1	
Portugal	34	20	14	10	6	4	1	1	0	
Romania	61	33	28	21	11	10	18	12	6	
Slovakia	27	17	10	9	6	3	4	2	1	
Slovenia	18	12	6	5	4	2	2	1	1	
Spain	156	122	34	39	30	9	13	9	5	
Sweden	37	29	8	23	18	5		Not availa	ble	
United Kingdom	271	219	51	56	45	11	83	56	26	

The HSE estimates that in the UK approximately 300 workers are directly exposed during polyurethane production (Cocker *et al*, 2009), which agrees well with the 271 estimated to be exposed using the overall prevalence and EUROSTAT data (Table 2.1), suggesting that for the UK, the estimated figures are reasonable.

Classification of Industries by Exposure Level

Industries in which exposure to MbOCA occurred in approximately 1975 have been classified as high, medium, low or background exposure based on an evaluation of the peer-reviewed literature, information from industry and expert judgement. The industries, grouped by NACE code, were identified from the CAREX data and stakeholder information. The exposure classification by industry is presented in Table 2.2.



Table 2.2 Classification of industries by MbOCA exposure level in 1975

Industry	NACE (rev 1.1)	Classification
Manufacture of chemicals and chemical products	24	L
Manufacture of basic chemicals	24.1	L
Manufacture of rubber and plastic products	25	Н
Manufacture of rubber products	25.1	Н
Manufacture of plastic products	25.2	Н
Manufacture of machinery and equipment n.e.c.	29	L
Research and development	73	L

2.3 LEVEL OF EXPOSURE TO MBOCA

2.3.1 Estimation of exposure levels

The available scientific literature was reviewed for MbOCA occupational exposure data. The most comprehensive studies have been carried out in the UK by the Health and Safety Executive (HSE). One study was carried out in 2005/6 (McNally and Binchy 2007, Cocker *et al*, 2009) and a follow up study in 2008 (Keen, 2009). Exposure to MbOCA was assessed by air samples (2005/6 study only), gloves, surface wipes and urine samples. No air sampling was carried out in the second study since previous studies indicated that inhalation was not a major route of exposure (there was no relationship between airborne levels of MbOCA and urinary MbOCA). This is supported by a US study (Fairfax and Porter, 2006), which reported that all personal MbOCA air samples collected at a urethane caster position were below the limit of detection, though the number of samples is not given. Of the 80 air samples collected in the first HSE survey, 67 were below the limit of detection, for the remaining 13 samples, the geometric mean was 1.3 (GSD=2.9) μ g/m³.

Table 2.3 Urinary concentration of MbOCA (µmol/mol creatinine)

Group	Year -	No. of mea	asurements	Expo	sure
Group	i eai -	< LOD	> LOD	Median	90 th %ile
Directly exposed	2005/6	19	40	3.1	16.7
Directly exposed	2008	145	10	1.6	11.1
Indirectly exposed	2008	25	366	<lod< td=""><td>2.1</td></lod<>	2.1
All exposed*	2008	170	40	1.4	10.0

^{*} All exposed – directly and indirectly exposed

Statistical analysis indicated that for exposed workers there was no significant reduction in MbOCA urinary levels between the 2005/6 and 2008 surveys, although concentrations were 10% lower.

Surface contamination with MbOCA has been reported by Fairfax and Porter (2006), Cocker *et al* (2009) and Keen (2009). Keen (2009) demonstrated a positive correlation between glove contamination and urinary MbOCA, further supporting the dermal route of exposure for MbOCA.



Due to the limited availability of exposure data it was not possible to determine whether there are systematic differences in exposures across the EU and we have assumed that the values presented by the HSE (Cocker et al 2009, Keen 2009) are typical of exposures throughout the EU. Geometric means and standard deviations are only available from the 2005/6 survey and were calculated using only those values greater than the limit of detection. Median values are presented from both surveys for all values for those directly exposed, since no significant difference between the two medians was reported, it is suggested that the mean, 2.3 µmol/mol is taken to be representative of the current geometric mean. Geometric standard deviations for values greater than the limit of detection were reported for only for 2005/6. These varied from 1.2 to 2.3. Inclusion of values less than the limit of detection are likely to increase the geometric standard deviation. Seventy-eight urine samples from the 2005/6 survey were analysed for MbOCA. Using the reported geometric mean (5.0 µmol/mol) and standard deviation (2.1) from the 2005/6 survey for the 40 individuals with urinary concentrations greater than the limit of detection, @Risk was used to generate 40 concentrations. Using the minimum value from these simulations, half that value was taken to be representative of the 38 values for which the concentration was less than the limit of detection. The geometric standard deviation was then calculated for all 78 values and was found to be 3.58. Based on this it is suggested that a geometric mean of 2.3 µmol/mol and a geometric standard deviation of 5.0 be used in subsequent calculations of exposure burden to MbOCA in the EU.

2.3.2 Temporal change in exposure

The available scientific literature was reviewed for historic MbOCA occupational exposure data. Again, the most relevant and comprehensive studies have been carried out in the UK by the Health and Safety Executive (HSE).

Cocker *et al*, 2008 reported a gradual reduction in MbOCA over the years. In 1977 the 90^{th} percentile of biological monitoring data from workplaces was 180 µmol/mol. This was reduced to 30 µmol/mol in 1983 and became a Biological Action Limit (BAL) and to 15 µmol/mol in 1993 when it became a Biological Monitoring Benchmark Value. Since then the 90^{th} percentile of biological monitoring data has been < 10 µmol/mol.

In order to study possible temporal trends in exposure to MbOCA an exponential regression equation of the form $y = a.e^{-bx}$ was fitted to the 90^{th} percentiles of the urinary concentration values for 1977, 1983, 1996 and 2008. The regression coefficient was then used to calculate the average annual change in concentration over the period for which exposure was estimated.

The temporal trends were expressed as the annual change in 90th percentile concentration using the following expression:

% change per year =
$$100 * (exp[b] -1)$$

An annual decline of 7.9% in 90th percentiles was calculated. If it is assumed that this value is also representative of the annual decline in geometric mean exposure, this is close to the median value of 7% from the results reported for annual decline in exposure for various substances by Creely *et al* (2007).



2.3.3 Proportion of exposures above the suggested BMGVs

Based on the exposure estimates and the assumed trend in exposure, the predicted proportion of workers exceeding the BMGVs selected for the intervention scenarios are shown in Table 2.4. Between 1971 and 1980 it was estimated that 64% of exposures were above 15 μ mol/mol and 85% above 5 μ mol/mol. By 2021-2030 the predicted proportion of exposures above 5 μ mol/mol has reduced to 7% with only 1% above 15 μ mol/mol.

Table 2.4 Estimated proportion of workers above the identified BMGV values

Year	1971-80	1981-90	1991-00	2001-10	2011-20	2021-30
5 µmol/mol	85%	71%	51%	31%	16%	7%
15 µmol/mol	64%	44%	26%	12%	5%	1%

2.4 HEALTH IMPACT FROM CURRENT EXPOSURES

2.4.1 Background data

The occupational cancers associated with exposure to MbOCA are listed in Table 2.5 along with a summary of the information used in the health impact assessment.

Table 2.5 Occupational cancers associated with exposure to MbOCA

Cancer site	Bladder
ICD-10 code	C67
IARC group for carcinogen	2A
Strength of evidence for cancer site (1)	Suggestive
Latency assumption	10-50 yrs
Source of forecast numbers - deaths	Eurostat, 2006
	GLOBOCAN, 2002 ⁶
registrations	
Exposure levels	Relative Risk (RR) Source of RR
"High"	3.28 (0.40-11.84) Dost <i>et al</i> (2009)
"Low"	1

⁽¹⁾ Based on Siemiatycki et al., 2004

2.4.2 Exposed numbers and exposure levels

Industry sectors, their NACE codes and classifications to High/Medium/Low/Background exposure as applicable for the mid 1970's are given by country in Table 2.2 in the previous section on the exposure. The estimated average exposure level (GM) and measure of variability (GSD) for NACE industries used are 2.3 µmol/mol and a geometric standard deviation of 5.0 for 2001-2010.

We present data for a "baseline" trend scenario which for all industries assumes a 7.9% annual decline in exposure levels and standard change in employed numbers up to the 2021-30 estimation interval and constant levels thereafter.

⁶ IARC, GLOBOCAN database, available at: http://www-dep.iarc.fr/globocan/database.htm



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2.4.3 Forecast cancer numbers

Separate estimates for total numbers of deaths for bladder cancer by age band are available from EUROSTAT for the 27 countries of the EU, for 2006, and for registrations from GLOBOCAN for 2002. The forecast numbers of deaths and registrations by country used to estimate attributable numbers are in Appendix 8.1.

2.4.4 Results

The cancer deaths and registrations attributed to occupational exposure to MbOCA for the baseline scenario are presented per year for the target years given and are based on the all working age cohort of currently (2006) exposed workers. Attributable fractions and numbers of deaths and registrations, and Years of Life Lost (YLLs), Years Lived with Disability (YLDs) and Disability Adjusted Life Years (DALYs), are estimated.

As the exposure data suggests that exposure declines over time, a dynamic baseline scenario has been used.

A summary of the results for the total EU is in Table 2.6 below.

Table 2.6 Results for the baseline forecast scenario, total EU (27 countries), men plus women⁷

Scenario	All sc	enarios	employ	line (trend) s yment and e ed to 2021-3	exposure lev	el trends
EU Total	2010	2020	2030	2040	2050	2060
Numbers ever exposed	13,204	13,486	13,856	13,988	14,062	14,126
Proportion of the population exposed	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%
Bladder cancer						
Attributable Fraction	0.006%	0.005%	0.003%	0.002%	0.001%	0.000%
Attributable deaths	3	3	2	1	1	0
Attributable registrations	8	8	6	3	2	1
'Avoided' cancers						
YLLs	30	28	21	13	7	3
DALYs	39	36	27	17	8	4

The attributable deaths and registrations in 2010 from past exposure to MbOCA were very low (3 and 8 cases, respectively). Over the next 50 years the health impact is predicted to decrease so that by 2060 there is one predicted registration and less than one death. The corresponding estimated attributable fraction for bladder cancer decreases from 0.006% in 2010 to 0.000% in 2060. Estimates for Years of Life Lost and DALYs also decrease so that by 2060 there are predicted to be 3 YLLs and 4 DALYs arising from MbOCA exposures in Europe.

⁷ Deaths and registrations are rounded to the nearest whole number. Where YLLs/YLDs/DALYs appear in association with zero deaths/registrations, this is due to rounding the deaths/registrations down to zero.



2.5 POSSIBLE COSTS ASSOCIATED WITH NOT MODIFYING THE DIRECTIVE

2.5.1 Health impacts – possible costs under the baseline scenario

Introduction

The health data (cancer registrations and YLL) for the baseline in which there are no further modifications to the Carcinogens Directive were described in Section 2.4. These data indicate that there are predicted to be a significant number of cancer registrations (280 over the period 2010-2070⁸) and YLLs (1,020 over the period 2010-2070⁸) from bladder cancer resulting from future exposure to MbOCA. There is a predicted decline in registrations and YLLs over the time period of this study (2010-2070) under the baseline scenario as a result of predicted exposure reduction due to the implementation of existing and on-going risk management measures across the EU.

Method in brief

Using the health data (cancer registrations and YLL), it is possible to monetise the costs under the baseline by estimating the:

- Life years lost This is calculated by using the YLL and multiplying this by a valuation of the Value of Life Year Lost (VLYL). This gives a value for the time (in years) lost as a result of premature death.
- Cost of Illness (COI) This is a monetary cost of the time spent with cancer. In this study, a unit COI estimate is multiplied by the number of cancer registrations to give a total value for COI. (COI is often the main market-based approach in relation to health impact⁹). COI includes the direct and indirect costs of cancer but not the intangible costs (see below).
- Willingness to Pay (WTP) to avoid cancer WTP is used as an alternative method (high cost scenario) based on publically available, peer reviewed studies on what people would be willing to pay to avoid having cancer. This includes various intangible costs (e.g. disfigurement, functional limitations, pain and fear) and in some cases also includes the costs associated with life years lost.

The cost variables used in this study are presented in Table 2.7 in 2010 prices. For the purposes of this study, valuations are increased by 2% each year in the future in part to present costs in real terms (i.e. adjusting for inflation in prices) and to reflect the increasing value society's attaches to its health (as economic growth typically increases over a long period of time)¹⁰.



⁸ Note health estimates are provided for "snap-shot" years; 2010, 2020, 2030 etc. Results for a "snap-shot" year are assumed to be representative for the relevant time period (i.e. 2010 is also representative for 2010-2019) so impacts are multiplied by 10.

⁹ ECHA (2008) "Applying SEA as part of restriction proposals under REACH" Available at: http://echa.europa.eu/doc/reach/sea workshop proceedings 20081021.pdf

¹⁰ This is consistent with some other European Commission studies and is standard practice for air quality under the Clean Air for Europe (CAFE) programme.

Table 2.7 Summary of cost variables used in this study (€ 2010 prices)

Cost/benefit elements	Low scenario	High scenario
VLYL - Each year lost	€ 50,393	€ 0 (note 1)
COI or WTP - Unit cost (per cancer registration)	€ 49,302 (COI)	€ 1,793,776 (WTP)

(Note 1) – By using WTP (€1.8m) in the high scenario instead of COI, the WTP can include the costs of premature death and therefore there was a risk of double counting benefits if VLYL costs were included.

All costs and benefits over time in this study are discounted using a 4% discount rate as recommended by the European Commission's Impact Guidelines¹¹. In order to assess the effect that discounting has on the results ('sensitivity analysis'), we have also presented estimates that take into consideration a declining discount rate for impacts occurring after 30 years and no discounting.

The health data shown in section 2.3 are snap-shots (i.e. estimation for the initial year of a ten year period) of the number of cancer registrations, deaths, YLLs in future years at 10 year intervals. In calculating the costs associated with these effects, each snap-shot result is multiplied by 10 in order to derive an estimate for the whole assessment time period (for example, 2020 results are multiplied by 10 to give results over the period 2020-2029). This assumes that each snap-shot year is representative of the following 10 years.

The method to valuing health benefits is explained in more detail in the method paper titled "Valuing health benefits – Method paper".

Results

The health costs under the baseline scenario are presented in Table 2.8. Health costs are predicted to decline over time and are predominantly the result of past exposure. In Section 2.4 the numbers of cancer registrations and YLLs were estimated to decline over time, accounted for by risk management measures already imposed over the past 10-20 years.

The introduction of an EU-wide biological monitoring limit (BMGV) is not therefore expected to have significant impacts in the short term given that short term impacts occur due to past exposure (10-20 years). Table 2.8 sets out the range of health costs for each representative decade. The ranges are based on the high and low cost scenarios (see Table 2.7). The results are also illustrated in Figure 2.1.

¹¹ European Commission impact Assessment Guidelines (Jan 2009) http://ec.europa.eu/governance/impact/commission_guidelines/docs/iag_2009_en.pdf



Table 2.8 Health costs - baseline scenario – 2010 to 2070 (Present Value – 2010 €m prices)

Costs by Gender (€m)	2010- 2019	2020- 2029	2030- 2039	2040- 2049	2050- 2059	2060- 2069	Total
Female	3 to 16	2 to 12	1 to 7	1 to 3	0 to 1	0 to 0	3 to 41
Male	14 to 120	11 to 92	7 to 57	4 to 28	1 to 11	1 to 4	38 to 313
Total	17 to 136	13 to 104	8 to 64	4 to 32	2 to 13	1 to 5	45 to 353

Notes:

Health costs - baseline scenario (2010 - 2070) - Low scenario □ Females ■ Males €140 €120 Health costs (€m) €100 €80 €60 €40 €20 €0 2010-2019 2020-2029 2030-2039 2040-2049 2050-2059 2060-2069 Time periods

Health costs - baseline scenario (2010 - 2070) - High ■ Females €140 €120 Health costs (€m) €100 €80 €60 €40 €20 €0 2010-2019 2020-2029 2030-2039 2050-2059 2060-2069 2040-2049 Time periods

Figure 2.1 Health costs - baseline scenario – 2010 to 2070 (Present Value – 2010 €m prices)



⁻ All costs are presented in present value using a discount rate of 4%. The low range is based on low estimates for costs of illness and life years lost. The upper range of costs relate to WTP estimates to avoid having cancer, which include intangible costs associated with having cancer.

⁻ Totals may not match to sums of females and male costs due to underlying small differences in raw data and rounding to whole number

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These predicted health costs will affect Member States differently depending upon the overall number of workers within affected industry groups, existing RMMs and the proportion of males and females within these groups. Figure 2.2 shows that France, Germany, Italy and the UK are predicted to have relatively high health costs, followed by Poland and Spain. Health costs in males are several times larger than those in females, due to the profile of the exposed workforce. The industrial sector estimated to be affected under the baseline is the manufacture of rubber and plastic products. It is likely that this sector is particularly affected as MbOCA is primarily used in the production of isocyanate-containing polymers and occupational exposure may occur at several stages of polymer production (see Section 2.3). This is shown in Figure 2.3.

Detailed tables are included in Appendix 8.2.



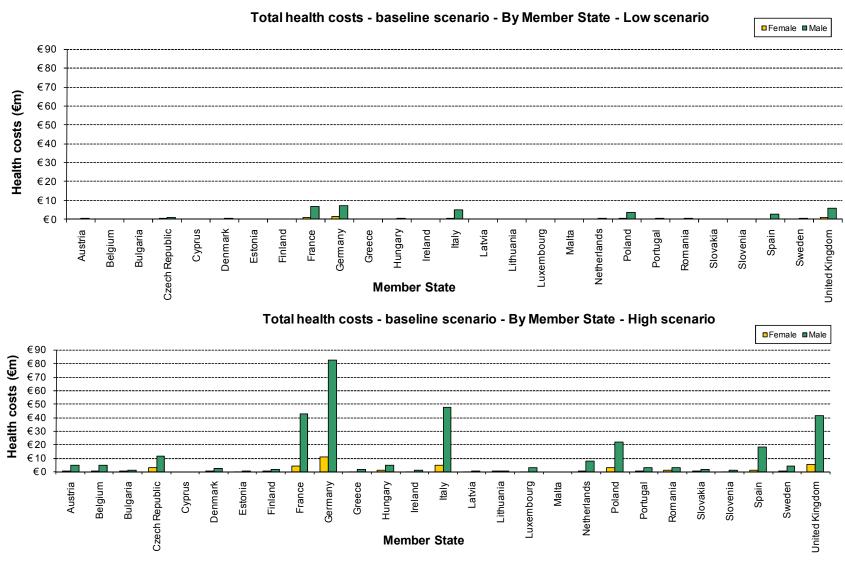


Figure 2.2 Total health costs- baseline scenario – By Member State (Present Value – 2010 €m prices)



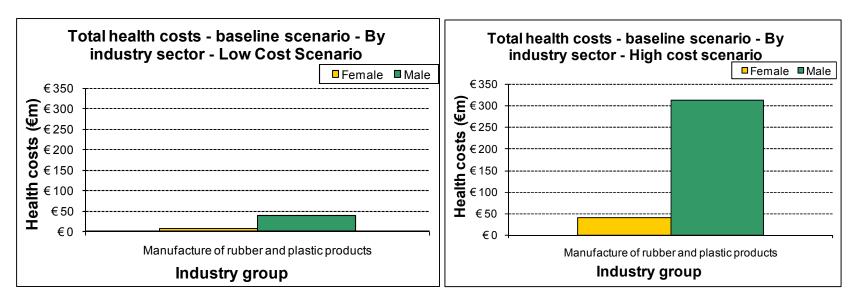
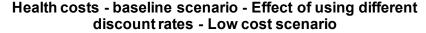


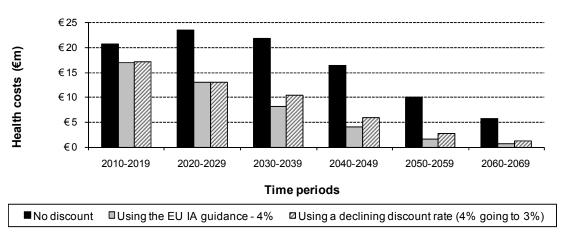
Figure 2.3 Total health costs - baseline scenario - by industry group (Present Value – 2010 €m prices)



In order to present all socio-economic costs and benefits consistently in present value terms, all future costs and benefits have been discounted. The primary approach was to apply the European Commission IA recommended 4% discount rate. Since most health impacts occur over a long period of time relative to costs, the impacts of discounting are significant.

In Figure 2.4 the effects of different discount rates on the overall results are shown, indicating that the impacts of discounting become more pronounced in the second and third assessment period (2020-2039). As the number of registrations and YLLs decline over time, the difference between using discounting and with no discounting becomes less evident (starts to decline in fourth assessment period 2040-2049). However, when there are more significant registrations and YLLs (as seen in years between 2010 and 2030) the impacts of discounting become more apparent.





Health costs - baseline scenario - Effect of using different discount rates - High cost scenario

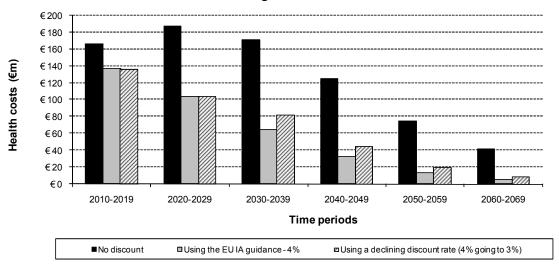


Figure 2.4 Impacts of discounting



3 POLICY OPTIONS

3.1 DESCRIPTION OF MEASURES

Existing national OELs in EU Member States are presented in Table 1.1. OELs in countries outside the EU are also presented for information. For those Member States for which there where OELs, and for outside jurisdictions, the long term OELs range from 0.003 to 0.22 mg/m³. However, there are no occupational limits for the majority of the EU Member States. For the purposes of this report OELs of 0.1 mg/m³ and above are considered typical for the EU.

However, as described in Section 1.2, an OEL for workplace concentrations in air is not likely to be a relevant limit, given that dermal exposure is the primary exposure route of concern. Instead it has been suggested that a biological monitoring limit (BMGV) be used. This report considers the impact of the potential implementation of an EU-wide BMGV of either 15µmol/mol or 5µmol/mol (in accordance with Section 1.2).

Companies in which MbOCA exposure would need to be reduced in order to meet these BGMVs would have a number of options, including organisational, personnel and technical measures. Examples of control measures to reduce exposure to MbOCA are summarised in Table 3.1.

Table 3.1 General measures to reduce exposure to MbOCA

Organisational measures	Personnel measures	Technical measures
Enclosed automated handling and processing should be used where reasonably practicable.	Use of personal protective equipment (PPE). Workers should have instruction and training in the proper donning and doffing of gloves to prevent contamination of skin.	Adequate local exhaust ventilation (LEV). Airflow indicators should be fitted to show the systems are extracting adequately
The work area should be arranged to minimise handling of MbOCA and/or isocyanates over long distances	Use of respiratory protective equipment (RPE)	Spillages need to be vacuumed as soon as they occur. The vacuum cleaner should be fitted with a high efficiency particulate arrestor (HEPA) filter.
Regular cleaning	Companies should have biological monitoring for MbOCA in place	
	Non-essential personnel should not be allowed access to MbOCA and isocyanate processing areas.	

Source: UK Health and Safety Executive (HSE) 'Inspection of premises using MbOCA and isocyanates in the manufacture of moulded polyurethane articles'. Available at: http://www.hse.gov.uk/foi/internalops/sectors/manuf/03-10-07.htm#control

Occupational MbOCA exposure may occur at several stages of polymer production, where un-reacted MbOCA exists and where prepolymers are mixed with molten



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MbOCA before moulding. Based on the use and the properties of MbOCA, exposure can occur through the following means¹²:

- skin contact and subsequent absorption into the body;
- inhalation of dust, or, upon heating, vapour; and
- ingestion of small quantities of condensed MbOCA vapours picked up from equipment surfaces (due to poor cleaning and hygiene practices).

Specific control measures used to limit exposure to MbOCA include:

- Enclosure automated handling and processing;
- Effective local exhaust ventilation (LEV);
- Using suitable gloves for handling. These should include inner gloves for chemical protection (either disposable nitrile or reusable nitrile or vinyl) and outer gloves or gauntlets for thermal protection. Gloves should extend beyond the wrist¹³.

Inhalation Exposure

LEV is considered to be an efficient means of controlling inhalation exposure as it removes the contaminant at the point of generation (Health Canada, 2006). Health Canada (2006) recommends that where there is a likelihood that workers may be exposed to MbOCA dust or vapour, LEV should be installed, for instance in the following locations:

- where MbOCA is transferred from the shipping containers;
- weighing, degassing and mixing stations;
- machine dispensing heads;
- casting and hot tables; and
- heating and curing ovens.

Dermal Exposure

The main route of exposure to MbOCA is through dermal absorption during direct handling and through touching contaminated surfaces and/or contaminated PPE. Handling of MbOCA during the production of polyurethane elastomers can be either manual or automatic. In the batch (hand) mixing/casting process, exposure to MbOCA can potentially occur during the following steps (Health Canada, 2006):

- transferring material from shipping containers into the melt containers (MbOCA is usually supplied in pellets or granules. There is the potential for some dust release when granules are decanted);
- · during the melting process;

¹² Canadian Urethane Manufacturer's Association (CUMA) (2001) *Handling MBOCA Safely*¹³ UK Health and Safety Executive (HSE) 'Inspection of premises using MbOCA and isocyanates in the manufacture of moulded polyurethane articles'. Available at: http://www.hse.gov.uk/foi/internalops/sectors/manuf/03-10-07.htm#control



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- when transferring molten MbOCA from the container in which it was melted into a secondary container for weighing or when it is added to the prepolymer; and/or
- casting into moulds if there is direct skin contact with the uncured mixture.

In the machine mixing/ casting process, exposure to MbOCA can potentially occur during the following steps:

- transferring material from shipping containers into the processing melt tank;
- when first setting up the machines polymer to MbOCA ratios;
- during melting and metering, depending on the extent that evaporative and dust emissions are actually controlled;
- when casting into moulds if there is direct skin contact with the uncured mixture; and/ or
- when the machine is flushed with solvents or plasticizers.

3.2 LEVEL OF PROTECTION ACHIEVED (OELS)

Although Cocker *et al* (2009) reported that all firms in the 2005/6 survey handled MbOCA under LEV, 70% of firms failed to have their LEV systems appropriately tested as required under UK regulations. Further, the LEV systems used to control exposure during MbOCA and resin handling were often ineffective or inefficient due to poor maintenance. The 2008 survey (Keen, 2009) reported that there have been no significant changes in MbOCA use and exposure control. In both studies poor use and maintenance of respiratory protective equipment (RPE) and personal protective equipment (PPE) was reported, along with poor housekeeping resulting in surface contamination outside MbOCA handling areas, inadequate welfare facilities, inadequate health surveillance, poor training and eating and drinking within MbOCA handling areas.

Although airborne levels in 2005/6 were not shown to be correlated with urinary MbOCA levels, higher levels were found where appropriate controls were not used (Cocker *et al*, 2009).

Regular monitoring of urinary MbOCA in the UK has indicated that the setting of guidance values in 1987 (30 μ mol/mol) and 1996 (15 μ mol/mol), which were based on the 90th percentile values of collected data, resulted in a lowering of levels, probably through improvements of exposure controls (Cocker *et al*, 2009). Cocker *et al* (2009) suggest that the current level of 15 μ mol/mol no longer acts as a stimulus for companies to reduce exposure. In Finland a limit of 5 μ mol/mol is in force and Cocker (personal communication) has indicated that should the limit be set in 2010 it is likely that this level would be chosen. Data from the recent surveys in the UK indicate that it should be possible to limit exposures to this level, particularly since there are still areas where improvements are possible as discussed above. Keen (2009) suggest that improved training and supervision rather than implementation of additional engineering controls is especially important in reducing exposures.



4 ANALYSIS OF IMPACTS

4.1 HEALTH IMPACTS FROM CHANGES TO THE EU DIRECTIVE

4.1.1 Health information

For MbOCA, limits of 15 and 5 µmol/mol are to be tested. Changes in bladder cancer numbers have therefore been estimated given current (baseline) and full compliance¹⁴ with these limits. As set out previously, the baseline for all industries assumes a 7.9% annual decline in exposure levels and a standard change in employed numbers up to the 2021-30 estimation interval and constant levels thereafter.

We present data for two "intervention" scenarios as described in Table 4.1 below, compared to the baseline trend scenario described in section 2.4.

Table 4.1 Baseline and intervention scenarios

Intervention scenarios ⁽¹⁾						
Baseline (trend) scenario (1)	Linear employment and exposure level trends assumed to 2021-30, constant thereafter.					
Intervention scenario (2)	Full compliance for BMGV = 15 μmol/mol					
Intervention scenario (3)	Full compliance for BMGV = 5 µmol/mol					

⁽¹⁾ All intervention scenarios are estimated as change to (1) the baseline scenario

Results for bladder cancer under the baseline scenario (1) and intervention scenarios compared to the baseline scenario are in Figure 4.1 (attributable registrations), Figure 4.2 (AFs) and Figure 4.3 (DALYs) for men plus women for the total EU (27 countries).

Due to the latency period, compliance with the limits from 2010 or soon afterwards would avoid cancers occurring but only from around 2040 onwards (Figure 4.1 and Figure 4.2).

¹⁴ Full compliance is assumed in the intervention scenarios; however, due to modelling restrictions full compliance is modelled as 99% compliance.



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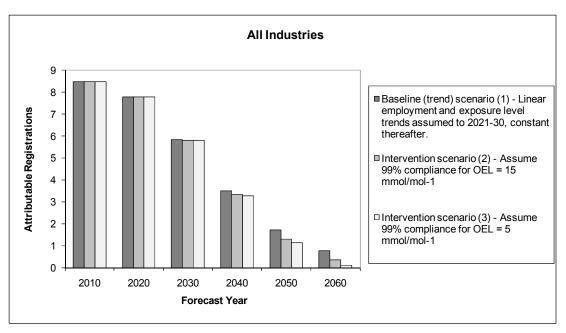


Figure 4.1 Results for intervention scenarios compared to the baseline scenario (2) – Occupation Attributable cancer registrations, Bladder cancer, men plus women

Figure 4.1 shows that the predicted number of cancer registrations drops steadily over the next fifty years for both intervention scenarios and the baseline scenario.

Figure 4.2 shows that the attributable fraction decreases over the period up to 2060. The decrease is similar for all three scenarios resulting in approximately <0.001% of all bladder cancer attributed to MbOCA exposure by 2006 for all three scenarios.

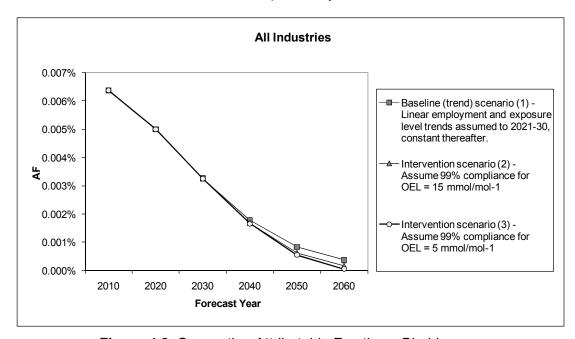


Figure 4.2 Occupation Attributable Fractions, Bladder cancer

The estimate DALYs drops from just below 40 years in 2010 for all three scenarios to below 5 years in 2060 for the baseline and intervention scenarios (Figure 4.3)



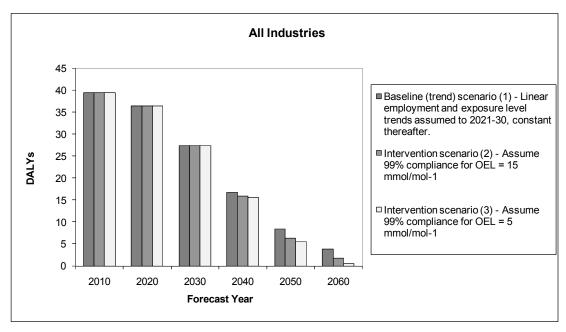


Figure 4.3 Occupation Attributable DALYs, Bladder cancer

Table 4.2 summarises the data shown in the previous figures. The data for the first two time periods (2010, 2020) are identical for all scenarios, and then the data for the intervention scenarios are shown in the two groups of four columns (2030-2060). Attributable lung cancer deaths decrease from 3 in 2010 to <1 in 2060 for both intervention scenarios.

In Table 8.3.1 in Appendix 8.3 are the estimated proportions exposed above the limits to be evaluated, as estimated under the baseline trend scenario (1, in table below). Under the alternative change scenarios they behave as determined by the scenarios (2 and 3), i.e. after 2010 full compliance is assumed.

Full results are given in Appendix 8.3 for men plus women by country in Table 8.3.2 and 8.3.3. A breakdown of attributable numbers by industry is in Tables 8.3.4 and 8.3.5. Estimates of numbers of cancer registrations 'avoided' in each of the forecast target years from 2030 onwards relative to the baseline scenario can be obtained by subtraction. Data for men and women separately, and by industry within country, are available in supplementary spreadsheets (*MbOCA Report data.xls*), if required.



Table 4.2 Results for the intervention scenarios, total EU (27 countries), men plus women¹⁵

Scenario	All scenarios		Intervention scenario (2) - Assume full compliance for BMGV = 15 µmol/mol			Intervention scenario (3) - Assume full compliance for OEL = 5 µmol/mol				
EU Total	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060
Numbers ever exposed	13,204	13,486	13,856	13,988	14,062	14,126	13,856	13,988	14,062	14,126
Proportion of the population exposed	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%
Bladder cancer										
Attributable Fraction	0.006%	0.005%	0.003%	0.002%	0.001%	0.000%	0.003%	0.002%	0.001%	0.000%
Attributable deaths	3	3	2	1	1	0	2	1	0	0
Attributable registrations	8	8	6	3	1	0	6	3	1	0
'Avoided' cancers			0	0	0	0	0	0	1	1
YLLs	30	28	21	12	5	1	21	12	4	0
DALYs	39	36	27	16	6	2	27	16	6	0

4.1.2 Monetised health benefits

The possible health benefits (i.e. avoided healthcare costs and effects of having cancer and avoided life years lost) for the introduction of an EU-wide BMGV at 15µmol/mol and 5µmol/mol are shown in Table 4.3.

The changes in cancer impacts over the first 30 years (2010-2040) are predominately the result of impacts from past exposure that are predicted to continue to occur in the future (these are relatively small and the results under the intervention scenarios do not differ substantially from the baseline scenario over this period).

The benefits of introducing a BMGV in 2010 are more noticeable from 2040 onwards. Table 4.3 shows that the more stringent BMGV assessed (5 μ mol/mol) results in the greatest health benefits (\leq 1.5-10.6m over the period 2010-2070). The impacts of introducing a BMGV at 15 μ mol/mol are likely to result in a smaller benefit (estimated to be \leq 1.0-7.4m over the period 2010-2070). The results are also illustrated in Figure 4.4.

¹⁵ Deaths and registrations are rounded to the nearest whole number. Where YLLs/YLDs/DALYs appear in association with zero deaths/registrations, this is due to rounding the deaths/registrations down to zero.



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Table 4.3 Health benefits of intervention over time (Present Value – 2010 €m prices)

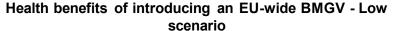
Costs by Gender (€m)	2010-2019	2020-2029	2030-2039	2040-2049	2050-2059	2060-2069	Totals	
Intervent	Intervention scenario (2) Introduce BMGV = 15µmol/mol							
Female	0 to 0	0 to 0	0 to 0	0 to 0	0 to 0	0 to 0	0 to 1	
Male	0 to 0	0 to 0	0 to 0	0 to 1	0 to 3	0 to 2	1 to 7	
Total	0 to 0	0 to 0	0 to 0	0 to 2	0 to 3	0 to 3	1 to 7	
Intervention scenario (3) - Introduce BMGV= 5µmol/mol								
Female	0 to 0	0 to 0	0 to 0	0 to 0	0 to 0	0 to 0	0 to 1	
Male	0 to 0	0 to 0	0 to 0	0 to 2	1 to 4	0 to 4	1 to 9	
Total	0 to 0	0 to 0	0 to 0	0 to 2	1 to 4	1 to 4	1 to 11	

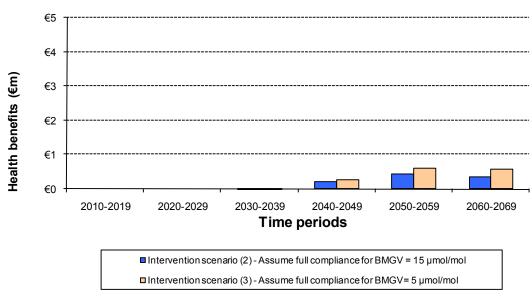
Notes:



[–] All costs are presented in present value using a discount rate of 4%

⁻ Totals may not match to sums of females and male costs due to underlying small differences in raw data and rounding to nearest million





Health benefits of introducing an EU-wide BMGV - High scenario

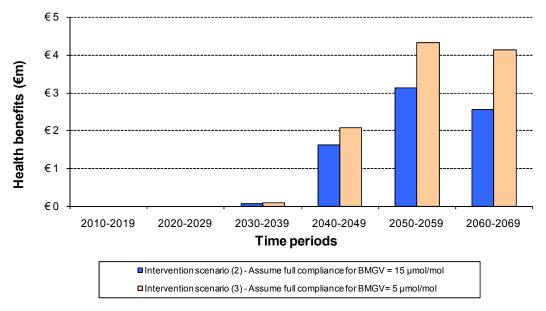


Figure 4.4 Health benefits over time of introducing an EU-wide BMGV (Present Value – 2010 €m prices)

These health benefits will affect Member States differently depending upon the overall number of workers within affected industry groups, existing risk management measures (RMMs) and the proportion of males and females within these groups. The total benefits are shown in Figure 4.5 (low scenario) and Figure 4.6 (high scenario) by Member State and in Figure 4.7 (low scenario) and Figure 4.8 (high scenario) by industry. France, Germany, Italy, Poland and the UK are predicted to particularly



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benefit from the BMGV assuming full compliance¹⁶. The highest benefits are seen in those Member States with the highest baseline health costs. For instance, Figure 2.2 shows that Germany is predicted to have the highest health costs without further intervention and Figure 4.5 shows Germany is expected to benefit the most from the introduction of an EU-wide BMGV (scenarios 2 and 3).

The benefits of a possible BMGV for MbOCA are likely to affect men more than women because the greatest proportion of costs under the baseline relate to impacts on men. The Member States and industry groups that are predicted to benefit most from a revised BMGV also vary at a gender level. A breakdown by gender is presented in Appendix 8.4.

¹⁶ The assumption of full compliance is a standard assumption used in EU Impact Assessments.



Total health benefits (2010 - 2070) of different BMGVs - By Member State - Low scenario

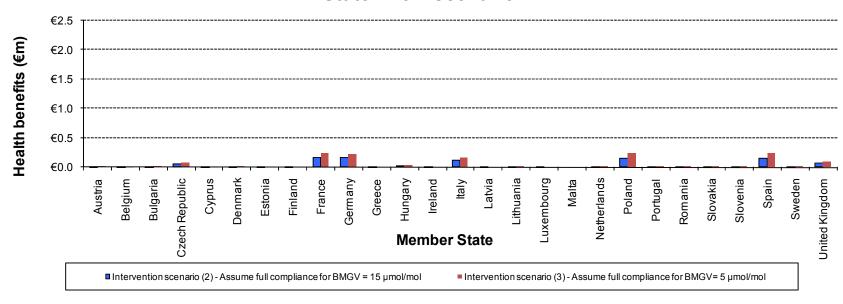


Figure 4.5 Total health benefits of introducing an EU-wide BMGV – By Member State – Low Scenario (Present Value – 2010 €m prices)



Total health benefits (2010 - 2070) of different BMGVs - By Member State - High scenario

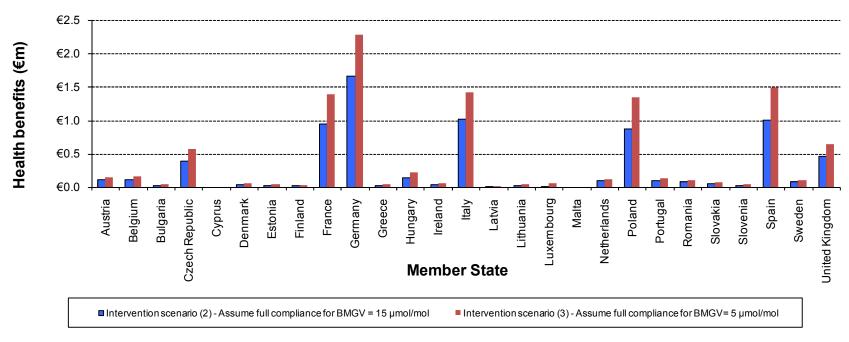


Figure 4.6 Total health benefits of introducing an EU wide BMGV – By Member State – High Scenario (Present Value – 2010 €m prices)



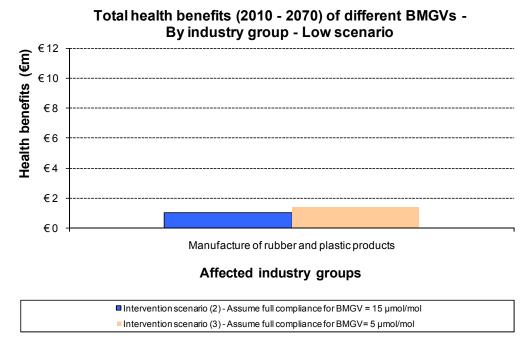


Figure 4.7 Total health benefits of introducing an EU-wide BMGV –
By Industry Group – Low Scenario

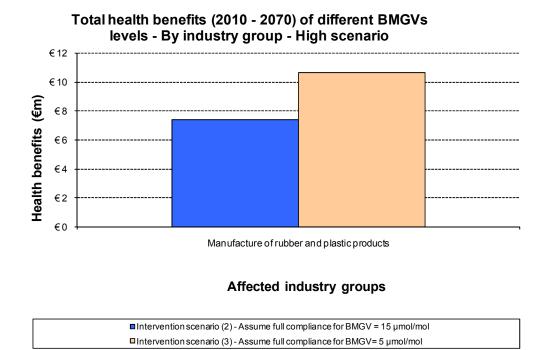


Figure 4.8 Total health benefits of introducing an EU-wide BMGV – By Industry Group – High Scenario

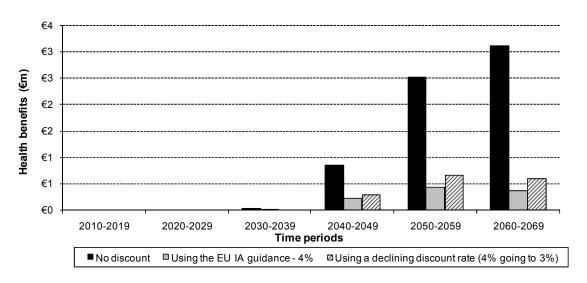


As with the baseline scenario, in order to present all costs and benefits consistently in present value terms, it is necessary to discount all future costs and benefits. This was done using the IA guidelines recommended 4% discount rate. Since most health impacts occur over a long period of time relative to costs, the impacts of discounting are significant. As a means of sensitivity testing, different discount rates are also used. The overall impact of discounting can be seen in:

- Figure 4.9 for introducing a BMGV of 15µmol/mol (Intervention scenario 2)
- Figure 4.10 for introducing a BMGV of 5µmol/mol (Intervention scenario 3)

Detailed tables are included in Appendix 8.5, with results presented using different discount rates.

Health benefits of Intervention scenario (2) - Low scenario



Health benefits of Intervention scenario (2) - High scenario

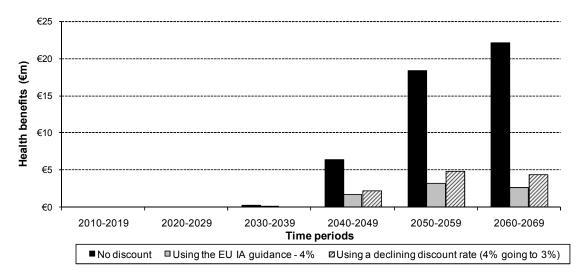
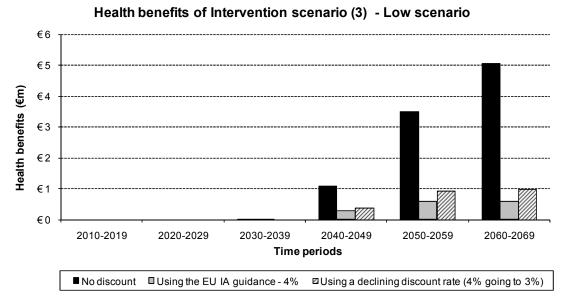


Figure 4.9 Impacts of discounting – Introducing a BMGV of 15 μmol/mol







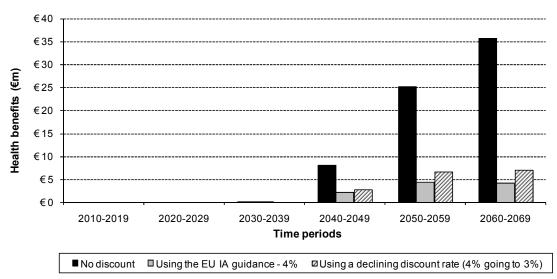


Figure 4.10 Impacts of discounting – Introducing a BMGV of 5 μmol/mol

Since the benefits of introducing an EU-wide BMGV would be mostly realised from 2040, the level of discounting has a significant impact on the overall size of health benefits. A limitation is that the benefits of any risk reduction measures undertaken post 2040 will not be included in this study, since the benefits of these measures to reduce occupational exposure in 2040-2070 are unlikely to be realised until after 2070 (due to the latency period in the development of cancer), a period which is not estimated in this study.



4.2 ECONOMIC IMPACTS

4.2.1 Operating costs and conduct of business

Compliance costs

In Section 2.2 it was estimated that there are approximately 2,500 workers typically exposed to MbOCA in the EU. The exposure data presented in Section 2.3 indicated that:

• The current geometric mean exposure of directly exposed workers is 2.3 µmol/mol (with a geometric standard deviation of 5.0).

Based on this, it is reasonable to make the following observations (assumptions):

- Most firms within affected industries are assumed to meet the most stringent biological monitoring limit (5 µmol/mol) given that the geometric mean exposure is 2.3µmol/mol (reflecting the fact that many firms will already have suitable control measures in place, see Table 2.4).
- It is estimated that, under the baseline scenario, firms are already moving towards reducing exposure, with an existing trend that would be expected to allow compliance with a 15 µmol/mol limit to be achieved. Further control could probably be achieved by better training and supervision. Therefore there is assumed there would not be a significant cost to achieve the 15 µmol/mol limit.
- Currently some firms within affected industries would require further control
 measures to meet the more stringent limit given that the estimated GSD
 indicates that there will be some firms/workers with exposure over 5
 µmol/mol.

This information has been used to help determine the number of workers that will comply with the proposed BMGVs (see Table 4.4).

Table 4.4 Estimated numbers of enterprises with exposure exceeding the possible BMGVs in affected industries

Sector (NACE Code)	Intervention scenario (2) - Assume full compliance for BMGV = 15 µmol/ mol		Intervention scenario (3) - Assume full compliance for BMGV = 5 µmol/ mol		
	% Workers affected ¹	No of. workers affected ²	% Workers affected	No of. workers affected	
Manufacture of chemicals and chemical products (24)	12%	168	31.5%	441	

Notes:

- 1) Percentages of workers affected are based on an assumption that exposure follows a lognormal distribution with mean of 2.3 µmol/mol and standard deviation of 5.0 µmol/mol as stated in Section 2.3.1. The percentage values were derived using these values and a lognormal probability density function developed using 10,000 iterations / sample points.
- 2) In Section 2.2 it was estimated that there are approximately 1,400 workers potentially exposed to MbOCA in high exposure industries (manufacture of rubber and plastic products). The number of workers affected is calculated as a percentage of the 1,400 workers potentially exposed.



It is estimated that an EU-wide BMGV of 15 μ mol/ mol would affect around 12% of potentially exposed employees, whilst a BMGV of 5 μ mol/ mol would affect just under a third of all workers (around 31%).

The UK HSE provides information on controls used in a variety of industries and processes to limit exposure to MbOCA. The HSE advises implementing effective LEV is to minimise inhalation exposure in the workplace¹⁷. It is important to recognise that many enterprises are already likely to have ventilation facilities (mobile and/ or stationary). However, it has been reported that many firms fail to have their LEV systems tested and furthermore, the LEV systems were often found to be ineffective or inefficient due to poor maintenance¹⁸. Since inhalation exposures appear to be already well controlled (low risk) under the baseline scenario, it has been assumed that there would be no compliance cost associated with installation or additional maintenance of LEV, primarily because dermal exposure rather than inhalation exposure appears to be the route by which cancer risk can be reduced.

It is understood that the dermal exposure route is most significant for MbOCA. According to a recent UK HSE survey, exposure is highly dependant upon individual working practices and relatively subtle differences in the way that exposure controls, especially gloves, are used¹⁷. A study focussed on UK occupational exposure to MbOCA found that:

"At 16 (80%) of the companies, the standard of housekeeping was poor with surface contamination not cleaned up immediately and allowed to accumulate on surfaces. At 70% of companies, there was evidence that reusable gloves were left on the bench during breaks with the potential for contamination [...] It was observed that most workers put on and remove their gloves at least four times a day and this may lead to contamination of the surfaces they were put on and contamination of inner gloves. The procedures used for glove reuse were not consistent with good practice and may be a result of lack of awareness and poor training" 18.

The HSE considers that a small number of workers with elevated exposures are currently increasing some statistical summaries of MbOCA exposures in the industry in the UK. They conclude that reducing the MbOCA exposures of these individuals could be achieved by improved training and supervision, rather than implementation of additional engineering controls.

There are expected to be relatively low costs associated with improved training, enclosure, housekeeping, RPE/ PPE, which in any case would be considered to be 'best practice'. It is assumed that these costs range between €1,000-2,000 per year per enterprise (including costs of equipment and the cost of time spent on e.g. cleaning and administration).

As illustrated in Table 4.5 below, the total compliance cost over the assessment period is estimated to be around \in 0.6 to \in 1.3 million for a limit of 15 µmol/mol and around \in 1.5 to \in 3.0 million for a limit of 5 µmol/mol.

¹⁸ Cocker J. *et al*, (2009) A Survey of Occupational Exposure to 4,4'-methylene-bis (2-chloroaniline) (MbOCA) in the UK, *The Annals of Occupational Hygiene*



¹⁷ UK Health and Safety Executive (HSE) 'Inspection of premises using MbOCA and isocyanates in the manufacture of moulded polyurethane articles'. Available at: http://www.hse.gov.uk/foi/internalops/sectors/manuf/03-10-07.htm#control

Table 4.5 Estimated cost of compliance per enterprise

	Number of enterprises affected		per year per rprise ¹		per year (all nterprises)	Total cost for all affected enterprises (2010-2070) ²		
Proposed BMGV		Low Scenario	High Scenario	Low Scenario	High Scenario	Low Scenario	High Scenario	
15 µmol/ mol	24	€1000	€2000	€24,000	€48,000	€ 564,682	€ 1,129,365	
5 µmol/ mol	63	€1000	€2000	€63,000	€126,000	€ 1,482,291	€ 2,964,582	

Notes: 1) Based on estimate that 'best practice' cost between €1,000-2,000 per year per enterprise

2) Costs are based on a 4% discount rate as recommended by the EC IA guidelines (2009)

Conduct of employers

The introduction of an EU-wide BMGV at 15 μ mol/mol or below may require certain enterprises to reorganise their workplace to ensure that exposure to MbOCA is minimised. Additional training and supervision of personnel handling the substance may be required to ensure that employees minimise their exposure by adhering to good practice in order to reduce exposure (e.g. good personal hygiene, wearing protective clothing, improved cleaning procedures and safety instructions). In particular, this relates to improved practices to reduce dermal exposure.

Potential for closure of companies

It is estimated that an EU-wide BMGV of 15 μ mol/mol would affect around 12% of potentially exposed employees and approximately 31% of workers would require further action to comply with a 5 μ mol/mol BMGV. It is assumed that these enterprises would require improved 'best practice' measures to comply, or to ensure existing 'best practice' measures are put into place, primarily to reduce dermal exposure.

Using the average annual operating surplus for specific sectors available from Eurostat, it is possible to understand whether firms are likely to be able to afford improving training and supervision or might opt to close the business or at least the part of their businesses that depends on the use of MbOCA. Table 4.6 shows the average operating surplus for firms with different employee numbers for firms in high exposure sectors (manufacture of rubber and plastic products). Operating surplus is a measure of profitability of the enterprise prior to payment of interest and tax (i.e. pre-tax profit income). The average surplus varies considerably according to the number of employees.

Table 4.6 Manufacture of rubber and plastic products (NACE 25)

Size of Enterprise by number of employees:	Number of enterprises (%)	Average operating surplus (€)	Cost / operating surplus (%)
Between 1 and 9	62.2	€ 44,879	2.2 – 4.4
Between 10 and 19	15.6	€ 209,511	0.5 - 1
Between 20 and 49	15.6	€ 435,632	0.2 - 0.5
Between 50 and 250	11.7	€ 1,577,052	0.1
Greater than 250	8.9	€ 10,195,912	0

Source: Eurostat classification of economic activities - NACE Rev.1.1. Summary of average Operating Surplus (Euros) per enterprise by Size of Enterprise (number of Employees). Data is for year 2006.



Table 4.6 indicates that the costs of capital as a percentage of annual profits are relatively small. The costs of compliance as a percentage of annual profits are more significant for those employing fewer than 10 people. However the costs are unlikely to be significant enough to result in closure of companies.

Potential impacts for specific types of companies

Recent studies on MbOCA exposure have reported poor use and maintenance of RPE and PPE, poor housekeeping, poor training and inadequate health surveillance in certain companies (e.g. Cocker *et al* 2009; Keen, 2009). Companies that do not currently implement 'best practice' procedures will be affected more by the implementation of an EU-wide BMGV than those who already have adhere to such procedures. There is no information available on the types of companies that would be specifically affected most (e.g. smaller rather than larger companies, those in specific regions or those undertaking specific activities).

Administrative costs to employers and public authorities

Seven European Member States have an existing regulatory long-term OEL in place (Austria, Belgium, Denmark, France, The Netherlands, Spain and the UK). However, these OELs are based on concentrations in air and, given the importance of dermal exposure, an EU-wide limit set as a BMGV would be more appropriate. This would require Member States to measure workers' urine concentration of MbOCA rather than airborne levels of MbOCA in the workplace. There may therefore be additional administrative costs as reporting structures may need to be altered and advice provided to companies to provide them with necessary information, such as the online advice provided by UK Health and Safety Executive¹⁹ (although this may only incur a one-off cost). Alternatively, the European Commission may decide to provide advice which could result in some cost-savings for national authorities.

Enterprises that already have urine sampling, monitoring and reporting systems in place will not be subject to any additional administrative costs. However, certain enterprises may not already be conducting biological monitoring under the baseline. The process of collecting samples may be fairly simple (sample bottle supplied by the laboratory, basic instructions given to workers and samples then returned to a laboratory). It is estimated that the cost of analysis per sample would be approximately €50/ worker and that monitoring of workers would take place once every five years²⁰.

As illustrated in Table 4.7 below, the total cost over the assessment period for biological monitoring of employees is estimated to be around €50,000 for a limit of 15 µmol/mol and around €140,000 for a limit of 5 µmol/mol.

⁰ Estimate based on expert judgement from IOM (2010).



¹⁹ UK Health and Safety (HSE) online guidance on biological monitoring. Available here: http://www.hse.gov.uk/pubns/indg245.htm

Table 4.7 Estimated costs for biological monitoring of potentially exposed employees

Proposed BMGV	Number of workers affected	Unit cost per year per worker	Total cost for all affected workers (2010-2070)1
15 µmol/ mol	168	€50	€ 53,421
5 μmol/ mol	441	€50	€ 140,230

Notes:

- 1. Costs are based on a 4% discount rate as recommended by the EC IA guidelines (2009). It is assumed that monitoring of workers would be conducted once every five years.
- 2. Costs have not been disaggregated per enterprise.

Whilst OELs are more appropriate for addressing inhalation exposure, those countries that have a national OEL in place are already likely to have implemented a data collection and reporting system. Therefore, it is likely that those Member States that do not have an existing OEL will incur greater costs of establishing and operating a data collection and reporting system.

Third countries

Since it is not expected that the introduction of an EU-wide BMGV will have a noticeable impact on companies, there is not expected to be any significant impact upon third countries such as through redistribution of investment, jobs or sales.

4.2.2 Impact on innovation and research

Impacts on innovation and research from introducing an EU-wide BMGV are estimated to be minimal, since PPE equipment is already widely used and the additional controls likely to be required by some firms are already being employed by other firms.

4.2.3 Macroeconomic impact

Insufficient data is available on the structure of the MbOCA market in the EU and therefore it is difficult to anticipate trends in production and demand.

In the event that additional exposure controls are required, short-term spending on risk management measures (e.g. PPE) may be good for the economy as equipment manufacturers (ventilation systems), installers and others will benefit with money flowing through the economy, if the alternative is that profits are retained (by shareholders or the company and not spent e.g. on research and development, meaning the wider economy would not benefit from increased spending). However, since it is expected that exposure can be minimised with improved employee best practice, cleaning, training and supervision rather than engineering control measures, it is likely in practice that there would be minimal or zero macroeconomic benefits from spending on risk-management relative to the baseline scenario from introducing an EU-wide BMGV.

With fewer life years lost and cancer registrations, there might be an economic benefit (for MbOCA manufacturers) through avoided loss of output and consumption in the future (post-2040), for example due to greater productivity from fewer sick days as well as wider benefits to society from greater consumption due to fewer premature deaths



and greater taxes raised. However, it is likely that at a macroeconomic level any benefit would be very small.

4.3 SOCIAL IMPACTS

4.3.1 Employment and labour markets

There are not expected to be any noticeable changes to the numbers of workers required as a result of introducing an EU-wide BMGV. However, job patterns may be altered as it is recognised that in order to meet a BMGV of 15 µmol/mol or lower, behavioural change amongst employees and updating health and safety training will be required.

4.3.2 Changes in end products

The majority of MbOCA is used in the production of polyurethane elastomers. This is not expected to change from the introduction of an EU-wide BMGV relative to the baseline scenario. However, the increased level of regulatory control – on top of that already required due to the classification of the substance – may further encourage the replacement of MbOCA with alternative (lower-risk) curing agents in polyurethane manufacture.

4.4 ENVIRONMENTAL IMPACTS

The ATSDR toxicological profile for MbOCA²¹ reports that the substance has a very low vapour pressure of 1x10⁻⁵ mmHg hPa at 25°C indicating that volatilisation from soil or surface waters is unlikely to be a major factor for environmental fate. MbOCA partitions to soil rather than water as a result of its low water solubility value (13.9 mg/l).

The chemical properties of MbOCA indicate that about 43% will enter the water, 28% aquatic sediments, and 30% terrestrial soil²². The estimated photo oxidation half-life of MbOCA in surface water is between 1.3 and 72 days. In groundwater it is estimated at between 8 weeks and 1 year. The estimated hydrolysis half-life of MbOCA in water at 25°C and pH7 is more than 800 years²¹.

Limited data is available on the ecotoxicological effects of MbOCA. The bioconcentration factor of MbOCA has been estimated to be 5.75 in aquatic organisms. It has been shown that MbOCA binds to and penetrates the roots of plants grown in contaminated soil and is not easily removed by rinsing. However, it stays very close to the root surface and is not distributed throughout the plant²¹. This information suggests that there is a potential for food chain bioaccumulation both from aquatic organisms and the root systems of terrestrial plants.

It is unlikely that the behavioural and/or technological changes that would be needed in order to comply with a new limit for MbOCA would lead to significant changes in releases of the substance to the environment. Therefore, there is expected to be little or no change in ecotoxicological risks as a result.

West Virginia Department for Environment Chemical Information for MbOCA. Available at: http://gis.wvdep.org/tri/cheminfo/csfs13.txt



²¹ Agency for Toxic Substances and Disease Registry (ATSDR) (1994) Toxicological Profile for 4,4'-methylenebis(2-chloroaniline) (MBOCA). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Likewise, because the changes required to meet a new limit are largely behavioural rather than technological, there are unlikely to be other significant environmental impacts (such as changes in energy use and associated emissions).

5 COMPARISON OF OPTIONS

The main impacts discussed in more detail in section 4 are summarised in the tables below, which are broken down by the main types of impacts (health, economic, social, macroeconomic and environmental).



Table 5.1 Comparison of health impacts by scenario (Present Value – 2010 €m prices)

	Baseline	Scenario	Introduce BM	GV=5 μmol/ mol	Introduce BMC	SV=15 μmol/ mol
Type of impact	Costs	Benefits	Costs	Benefits	Costs	Benefits
Health	As set out in section 2.5, the health costs of cancer (bladder) over the period 2010-70 are estimated to be: • Females: €3m to €41 • Males: €38 m to €313m • Total: €45m to €353m This range takes into consideration tangible costs (e.g. lost income, lost output from reduced productivity, medical costs, life years lost) and intangible costs (e.g. emotional and physical suffering from having cancer).	It is assumed that exposures fall by 7.9% per year in the future continuing the historical trend in reduced exposure. Therefore there are expected to be some reduction in health costs going forward in the absence of further regulatory intervention.	None - there is expected to be a cost saving from avoided health care and reduced cost of illness due to reductions in cancer registrations. This has been estimated as a benefit.	Health benefits of the proposed BMGV have been analysed at the Member State and industrial sector level. The results showed that the benefits of introducing a BMGV in 2010 are most apparent to the manufacture of rubber and plastics products sector from 2040 onwards. It was also found that the monetised benefits are likely to affect men more than women. The monetised benefits were estimated as: • Females: €0-1m • Males: €1-9m • Totals: €1-11m	None - there is expected to be a cost saving from avoided health care and reduced cost of illness due to reductions in cancer registrations. This has been estimated as a benefit.	The monetised benefits were estimated as: • Females: €0-1m • Males: €1-7m • Totals: €1-7m The impacts of introducing an EU-wide BMGV at 15µmol/ mol are estimated to have more limited health benefits as there is already estimated to be a reduction towards 15µmol/ mol under the baseline scenario.

Note: Costs and benefits under the intervention options are relative to the baseline scenario (i.e. are not absolute impacts but differences)



Table 5.2 Comparison of economic impacts by scenario (Present Value – 2010 €m prices)

Type of	Baseline Scena	ario	Introduce BMGV=5 μmol/	mol	Introduce BMGV=15 μmol/	mol
impact	Costs	Benefits	Costs	Benefits	Costs	Benefits
Economic	There are expected to be costs to some rubber and plastics manufacturing firms to put into place improved training and cleaning measures to reduce dermal exposure by 7.9% per year.		There are expected to be economic costs related to changes to workplace practices in order to meet the possible BMGV for the manufacture of rubber and plastic products sector. It is estimated that ~31% of enterprises would require some form of additional control measure to meet the proposed limit. The remainder are assumed to already be meeting the possible BMGV under the baseline scenario and therefore would require no further action. It is assumed that the majority of those that do not currently comply would need to implement relatively low-cost measures to reduce exposure levels to meet the BMGV. These costs (€1-2k) are not considered to be significant in comparison to gross operating surplus. There would be administrative costs of implementing the BMGV in national legislation and of demonstrating and verifying compliance.	Having an EU- wide BMGV should remove any EU competitive distortions between EU Member States with different limits.	There are expected to be economic costs related to changes to workplace practices in order to meet the possible BMGV for the manufacture of rubber and plastic products sector. It is estimated that ~12% of enterprises will require some form of control measure to meet the proposed OEL. The remainder are assumed to already be meeting the proposed BMGV under the baseline scenario and therefore will require no further action. It is assumed that the majority of those that cannot comply will need to implement 'best practice' low-cost measures to reduce exposure levels to meet the BMGV. These costs (€1-2k) are not considered to be significant in comparison to gross operating surplus. There would be administrative costs of implementing the BMGV in national legislation and of demonstrating and verifying compliance.	Having an EU- wide BMGV should remove any EU competitive distortions between EU Member States with different BMGV limits.

Note: Costs and benefits under the intervention options are relative to the baseline scenario (i.e. are not absolute impacts but differences)



Table 5.3 Comparison of social impacts by scenario (Present Value – 2010 €m prices)

Type of	Baseline	Scenario	Introduce BM	GV=5 μmol/ mol	Introduce BMGV=15 μmol/ mol		
impact	Costs	Benefits	Costs	Costs	Benefits		
Social	There are not expected to impacts under the baseline At an installation level, em their working practice (e.g reduce risks of dermal expectation).	e scenario at an EU level. ployees will need to change . hygiene and cleaning) to	Impacts are expected to b Some firms (63) will requir best practice.		Impacts are expected to be Some firms (24) will require best practice.		

Note: Costs and benefits under the intervention options are relative to the baseline scenario (i.e. are not absolute impacts but differences)

Table 5.4 Comparison of macro-economic impacts by scenario (Present Value – 2010 €m prices)

Type of	Baseline Scenario		Introduce BM	IGV=5 μmol/ mol	Introduce BMGV=15 μmol/ mol		
impact	Costs Benefits		Costs	Benefits	Costs Benefits		
Marco- economic	There are not expected t macroeconomic impacts scenario.	,		al engineering controls are experic impacts relative to the baseli	•		

Note: Costs and benefits under the intervention options are relative to the baseline scenario (i.e. are not absolute impacts but differences)

Table 5.5 Comparison of environmental impacts by scenario (Present Value – 2010 €m prices)

Type of	Baselin	e Scenario	Introduce B	MGV=5 μmol/ mol	Introduce BMG	SV=15 μmol/ mol
impact	Costs	Benefits	Costs	Benefits	Costs	Benefits
Environmental			would be needed to me improvements in training employees rather than	implementation of additional Therefore it is not expected e BMGV would lead to	the workplace that woul BMGV have already be	cted that achievement of o changes in

Note: Costs and benefits under the intervention options are relative to the baseline scenario (i.e. are not absolute impacts but differences)



6 CONCLUSIONS

Exposure to MbOCA may cause bladder cancer. The International Agency for Research on Cancer consider this substances as a human carcinogen and it is classified as a category 2 carcinogen in Europe under the classification and labelling regulations. The main potential exposure arises from skin contact and so it is most appropriate to consider a biological monitoring guidance value (BMGV) rather than an inhalation Occupational Exposure Limit. Two potential BMGVs were evaluated 5 and $15 \, \mu mol/mol$.

Bladder cancer is a relatively common cancer that is generally diagnosed on people over 60 years of age. There are about twice as many cases diagnosed on men compared to women. In the EU it comprises about 5% of all cancer incidence. About half of all people diagnosed with this cancer will die from their disease.

MbOCA is not manufactured in the European Union, although it is used as a curing agent in epoxy resins and mixed with isocyanate based resins to produce polyurethanes and elastomers. About 2,500 workers are probably exposed in the EU. Average exposures assessed from biological monitoring are probably about 2.3 $\mu mol/mol$ with about 16% of exposures above 5 $\mu mol/mol$ and about 5% above 15 $\mu mol/mol$. Average MbOCA exposures have been decreasing by about 7.9% per annum.

The predicted number of deaths from past occupational exposure to MbOCA is low (3 deaths and 39 Disability-Adjusted Life Years). Introducing a BMGV of either 5 or 15 μ mol/mol would reduce the health impact but only from about 2040 onwards. In 2060 with a BMGV of 15 μ mol/mol the estimated DALYs would be about half of that predicted for the baseline scenario (2 vs 4). With a limit of 5 μ mol/mol the there is no predicted DALYs.

If there is no limit value introduced the health costs over the next 60 years are estimated to be between €45m and €353m. The corresponding health benefits from introducing a limit are between €1m and €7m for the 15 µmol/mol limit and between €1m and €11m for the 5 µmol/mol limit. Corresponding cost of compliance over the same period are estimated as between €564m and €1,129m for the higher limit and between €1,482m and €2,964m for the lower limit.

It are not expected that there will be any important social, macro-economic or environmental impacts.



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8 APPENDIX

8.1 ESTIMATED DEATHS AND REGISTRATIONS IN THE EU FROM BLADDER CANCER

Table 8.1.1 Forecast number of bladder cancers in ages 25+ (aged 15+ for registrations), based on projected EU country populations

Bladder cancer deaths			ME	N					WON	1EN		
FTY	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Austria	372	488	623	791	957	951	172	189	230	280	334	331
Belgium	0	0	0	0	0	0	0	0	0	0	0	0
Bulgaria	387	404	445	490	531	548	119	125	136	142	147	149
Cyprus	32	44	59	77	96	115	3	5	7	9	12	15
Czech Republic	586	762	1,011	1,166	1,353	1,569	233	274	329	359	390	420
Denmark	408	536	672	754	810	811	175	210	252	279	295	294
Estonia	64	73	87	106	124	146	31	35	37	42	45	46
Finland	185	245	322	353	359	376	71	86	107	121	123	121
France	3,879	4,718	5,888	6,875	7,459	7,820	1,230	1,400	1,675	2,007	2,167	2,193
Germany (including ex- GDR from 1991)	4,075	5,444	6,257	7,520	8,350	7,819	2,005	2,360	2,572	2,989	3,319	3,069
Greece	921	1,098	1,264	1,532	1,792	1,942	200	256	283	334	385	410
Hungary	568	652	766	897	1,013	1,145	240	268	300	332	345	375
Ireland	138	192	267	354	458	569	67	84	113	149	188	234
Italy	4,620	5,650	6,689	7,945	9,277	9,511	1,257	1,474	1,668	1,918	2,236	2,314
Latvia	126	138	157	185	210	234	57	62	65	72	77	83
Lithuania	194	223	266	332	393	436	56	63	69	82	89	91
Luxembourg	22	30	40	54	64	70	8	9	10	14	17	19
Malta	34	47	68	81	86	101	8	11	15	17	18	20
Netherlands	900	1,196	1,600	1,869	2,025	1,974	367	441	555	646	690	673
Poland	2,446	3,056	3,942	4,731	5,213	5,936	649	768	928	1,113	1,141	1,238



Bladder cancer deaths			ME	N					WON	1EN		1
FTY	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Portugal	560	674	808	981	1,149	1,279	207	253	295	351	406	445
Romania	1,011	1,131	1,330	1,577	1,810	1,931	307	340	397	451	510	551
Slovakia	199	253	350	446	523	614	75	90	116	139	153	172
Slovenia	101	136	175	215	235	246	45	53	62	73	77	78
Spain	4,148	5,075	6,370	8,147	9,959	10,917	870	1,033	1,238	1,545	1,886	2,106
Sweden	491	608	759	837	924	987	181	205	250	276	299	317
United Kingdom	3,481	4,249	5,260	6,126	7,001	7,473	1,691	1,873	2,260	2,638	3,019	3,190
European Union (27 countries)	30,722	37,976	46,330	55,274	62,497	65,778	10,637	12,330	14,440	16,995	18,957	19,638

Bladder cancer			ME	N					WOM	IEN		
registrations FTY	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Austria	1,715	2,072	2,518	2,815	2,916	2,960	559	625	732	810	835	834
Belgium	2,030	2,449	2,895	3,176	3,304	3,430	548	627	724	793	823	842
Bulgaria	636	656	695	736	753	730	171	177	183	186	183	175
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0
Czech Republic	1,759	2,186	2,488	2,787	3,040	3,050	636	736	809	873	918	915
Denmark	784	971	1,101	1,174	1,168	1,207	255	300	338	360	362	368
Estonia	156	170	191	213	236	248	55	59	62	64	66	67
Finland	686	882	983	1,001	1,019	1,048	220	266	293	299	297	298
France	10,183	12,430	14,253	15,519	16,066	16,701	2,158	2,575	2,959	3,250	3,310	3,336
Germany (including ex- GDR from 1991)	22,629	26,022	29,785	31,514	30,871	29,765	7,445	8,054	8,924	9,346	9,152	8,754
Greece	2,311	2,632	3,018	3,441	3,670	3,591	467	529	590	658	693	673
Hungary	1,456	1,630	1,809	2,016	2,201	2,256	540	582	613	640	662	661



Bladder cancer			ME	EN					WOM	IEN		
registrations FTY	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Ireland	476	636	814	1,006	1,199	1,290	171	223	285	348	411	445
Italy	18,441	21,391	24,656	27,696	28,472	27,931	3,718	4,172	4,682	5,204	5,339	5,171
Latvia	205	217	243	270	293	304	72	73	78	81	83	84
Lithuania	351	382	450	510	552	583	105	111	124	133	136	136
Luxembourg	118	156	202	240	261	281	35	42	51	59	65	69
Malta	61	81	94	100	110	116	18	23	26	27	28	30
Netherlands	4,771	6,115	7,167	7,614	7,495	7,568	1,111	1,340	1,545	1,643	1,631	1,618
Poland	6,023	7,376	8,506	9,448	10,301	10,435	1,303	1,524	1,731	1,834	1,919	1,925
Portugal	1,695	1,958	2,269	2,570	2,754	2,790	467	532	601	666	699	695
Romania	2,508	2,757	3,134	3,579	3,840	3,818	678	738	809	890	929	916
Slovakia	522	675	833	961	1,088	1,120	165	201	240	265	287	294
Slovenia	182	233	281	309	324	313	50	57	65	70	72	69
Spain	12,477	15,309	18,883	22,192	23,633	23,079	1,710	2,022	2,425	2,846	3,090	3,035
Sweden	1,792	2,133	2,376	2,559	2,687	2,868	593	672	742	797	828	871
United Kingdom	9,713	11,527	13,260	14,634	15,638	17,095	3,654	4,144	4,754	5,296	5,627	6,031
European Union (27 countries)	102,412	121,289	140,370	155,410	162,871	164,733	26,842	30,599	34,652	37,902	39,265	39,223



8.2 SUPPLEMENTARY TABLES - COSTS UNDER THE BASELINE SCENARIO

Table 8.2.1 Health costs – baseline scenario – Member State breakdown – Based on a 4% discount rate

Low	Female	Male	Total	High	Female	Male	Total
Austria	€0	€0	€1	Austria	€ 1	€5	€6
Belgium	€0	€0	€0	Belgium	€ 0	€5	€5
Bulgaria	€0	€0	€0	Bulgaria	€ 0	€1	€1
Czech Republic	€0	€1	€2	Czech Republic	€3	€11	€ 14
Cyprus	€0	€0	€0	Cyprus	€ 0	€0	€0
Denmark	€0	€0	€1	Denmark	€ 0	€2	€3
Estonia	€0	€0	€0	Estonia	€ 0	€1	€1
Finland	€0	€0	€0	Finland	€ 0	€2	€2
France	€1	€7	€8	France	€ 4	€ 43	€ 47
Germany	€ 1	€7	€9	Germany	€ 11	€ 82	€ 93
Greece	€0	€0	€0	Greece	€ 0	€2	€2
Hungary	€0	€1	€ 1	Hungary	€ 1	€5	€6
Ireland	€0	€0	€0	Ireland	€ 0	€1	€1
Italy	€ 1	€5	€6	Italy	€ 5	€ 48	€ 52
Latvia	€0	€0	€0	Latvia	€ 0	€0	€0
Lithuania	€0	€0	€0	Lithuania	€ 0	€1	€1
Luxembourg	€0	€0	€0	Luxembourg	€ 0	€3	€3
Malta	€0	€0	€0	Malta	€ 0	€0	€0
Netherlands	€0	€1	€1	Netherlands	€ 1	€8	€8
Poland	€ 1	€4	€ 4	Poland	€ 3	€ 22	€ 25
Portugal	€0	€0	€1	Portugal	€ 1	€3	€ 4
Romania	€0	€0	€1	Romania	€ 1	€3	€ 4
Slovakia	€0	€0	€0	Slovakia	€ 0	€2	€2
Slovenia	€0	€0	€0	Slovenia	€ 0	€1	€ 1
Spain	€0	€3	€3	Spain	€ 1	€ 18	€ 19
Sweden	€0	€0	€ 1	Sweden	€ 1	€ 4	€ 5
United Kingdom	€1	€6	€7	United Kingdom	€ 5	€ 42	€ 47
TOTAL	€7	€ 38	€ 45	TOTAL	€ 41	€ 313	€ 353



Table 8.2.2 Health costs – baseline scenario – Industry group breakdown – Based on a 4% discount rate

Low	Female	Male	Total
Manufacture of rubber and plastic products	€7	€ 39	€ 46
TOTAL	€7	€ 39	€ 46

High	Female	Male	Total
Manufacture of rubber and plastic products	€ 41	€ 314	€ 356
TOTAL	€ 41	€ 314	€ 356

Note: Industry breakdown results may not equate exactly to Member State breakdown due to differences in underlying health data.



Table 8.2.3 Health costs – baseline scenario – Member State breakdown – Based on a declining discount rate

Low	Female	Male	Total	High	Female	Male	Total
Austria	€0	€1	€1	Austria	€1	€6	€6
Belgium	€0	€0	€0	Belgium	€1	€ 5	€6
Bulgaria	€0	€0	€0	Bulgaria	€0	€1	€2
Czech Republic	€1	€1	€2	Czech Republic	€3	€ 13	€ 16
Cyprus	€0	€0	€0	Cyprus	€0	€0	€0
Denmark	€ 0	€0	€1	Denmark	€0	€3	€3
Estonia	€ 0	€0	€0	Estonia	€0	€1	€1
Finland	€ 0	€0	€0	Finland	€0	€2	€2
France	€ 1	€8	€9	France	€4	€ 47	€ 52
Germany	€ 1	€8	€9	Germany	€ 12	€ 91	€ 103
Greece	€0	€0	€0	Greece	€0	€2	€2
Hungary	€0	€1	€ 1	Hungary	€1	€ 5	€7
Ireland	€0	€0	€0	Ireland	€0	€1	€1
Italy	€ 1	€6	€6	Italy	€ 5	€ 53	€ 58
Latvia	€ 0	€0	€0	Latvia	€0	€0	€0
Lithuania	€0	€0	€0	Lithuania	€0	€1	€1
Luxembourg	€0	€0	€0	Luxembourg	€0	€4	€4
Malta	€0	€0	€0	Malta	€0	€0	€0
Netherlands	€0	€1	€ 1	Netherlands	€1	€8	€9
Poland	€ 1	€ 4	€ 5	Poland	€ 4	€ 25	€ 29
Portugal	€0	€0	€1	Portugal	€1	€3	€4
Romania	€0	€1	€1	Romania	€1	€3	€5
Slovakia	€0	€0	€0	Slovakia	€0	€2	€2
Slovenia	€0	€0	€0	Slovenia	€0	€1	€1
Spain	€0	€3	€3	Spain	€1	€ 22	€ 23
Sweden	€0	€1	€1	Sweden	€1	€ 5	€5
United Kingdom	€ 1	€6	€7	United Kingdom	€6	€ 45	€ 51
TOTAL	€8	€ 42	€ 50	TOTAL	€ 45	€ 349	€ 394



Table 8.2.4 Health costs – baseline scenario – Industry group breakdown - Based on a declining discount rate

Low	Female	Male	Total
Manufacture of rubber and plastic products	€8	€ 44	€ 52
TOTAL	€8	€ 44	€ 52

High	Female	Male	Total
Manufacture of rubber and plastic products	€ 46	€ 350	€ 396
TOTAL	€ 46	€ 350	€ 396

Note: Industry breakdown results may not equate exactly to Member State breakdown due to differences in underlying health data.

Table 8.2.5 Summary

Costs by Gender (€m)	2010-2019	2020-2029	2030-2039	2040-2049	2050-2059	2060-2069
Female	3 to 16	2 to 12	2 to 9	1 to 5	0 to 2	0 to 1
Male	14 to 120	11 to 92	9 to 72	5 to 40	2 to 18	1 to 7
Total	17 to 136	13 to 104	10 to 82	6 to 44	3 to 20	1 to 8



Table 8.2.6 Health costs – baseline scenario – Member State breakdown – With no discounting

Low	Female	Male	Total	High	Female	Male	Total
Austria	€0	€1	€ 1	Austria	€1	€ 11	€ 12
Belgium	€0	€0	€0	Belgium	€1	€ 10	€ 11
Bulgaria	€0	€1	€ 1	Bulgaria	€1	€2	€3
Czech Republic	€1	€3	€ 4	Czech Republic	€7	€ 26	€ 33
Cyprus	€0	€0	€0	Cyprus	€0	€0	€0
Denmark	€0	€1	€ 1	Denmark	€1	€5	€ 6
Estonia	€0	€0	€0	Estonia	€0	€1	€2
Finland	€0	€0	€0	Finland	€0	€3	€ 4
France	€2	€ 15	€ 17	France	€8	€ 91	€ 99
Germany	€3	€ 15	€ 18	Germany	€ 23	€ 173	€ 196
Greece	€0	€1	€ 1	Greece	€0	€4	€ 4
Hungary	€1	€2	€2	Hungary	€3	€ 10	€ 13
Ireland	€0	€0	€0	Ireland	€0	€2	€3
Italy	€1	€ 11	€ 12	Italy	€ 10	€ 101	€ 111
Latvia	€0	€0	€0	Latvia	€0	€1	€ 1
Lithuania	€0	€0	€0	Lithuania	€1	€2	€2
Luxembourg	€0	€1	€ 1	Luxembourg	€1	€ 11	€ 12
Malta	€0	€0	€0	Malta	€0	€0	€0
Netherlands	€0	€1	€2	Netherlands	€1	€ 15	€ 16
Poland	€2	€9	€ 10	Poland	€8	€ 53	€ 61
Portugal	€0	€1	€1	Portugal	€2	€6	€8
Romania	€0	€1	€1	Romania	€2	€7	€9
Slovakia	€0	€0	€1	Slovakia	€1	€4	€ 4
Slovenia	€0	€0	€1	Slovenia	€0	€2	€3
Spain	€1	€7	€8	Spain	€3	€ 49	€ 52
Sweden	€0	€1	€1	Sweden	€1	€9	€ 10
United Kingdom	€2	€ 11	€ 13	United Kingdom	€ 10	€ 80	€ 91
TOTAL	€ 14	€ 83	€ 98	TOTAL	€ 86	€ 679	€ 765



Table 8.2.7 Health costs – baseline scenario – Industry group breakdown – With no discounting

Low	Female	Male	Total
Manufacture of rubber and plastic products	€ 15	€ 86	€ 101
TOTAL	€ 15	€ 86	€ 101

High	Female	Male	Total
Manufacture of rubber and plastic products	€ 89	€ 679	€ 768
TOTAL	€ 89	€ 679	€ 768

Note: Industry breakdown results may not equate exactly to Member State breakdown due to differences in underlying health data.

Table 8.2.8 Summary

Costs by Gender (€m)	2010-2019	2020-2029	2030-2039	2040-2049	2050-2059	2060-2069
Female	3 to 20	4 to 21	3 to 19	2 to 14	1 to 8	1 to 4
Male	17 to 146	20 to 165	18 to 152	14 to 111	9 to 67	5 to 37
Total	21 to 166	23 to 187	22 to 171	16 to 125	10 to 75	6 to 41



8.3 VALUING HEALTH BENEFITS – INTERVENTION SCENARIOS

Table 8.3.1 Proportions exposed above the exposure limits being tested by country, forecast scenario

	1971-80	1981-90	1991-00	2001-10	2011-20	2021-30	1971-80	1981-90	1991-00	2001-10	2011-20	2021-30
OEL	15 mmol/	15 mmol/mol-1 5 mmol/mol						nol-1				
Austria	0.64	0.44	0.26	0.12	0.05	0.01	5.00	0.71	0.51	0.31	0.16	0.07
Belgium	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Bulgaria	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Cyprus	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Czech Republic	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Denmark	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Estonia	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Finland	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
France	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Germany	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Greece	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Hungary	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Ireland	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Italy	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Latvia	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Lithuania	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Luxembourg	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Malta	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Netherlands	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Poland	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Portugal	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Romania	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07



	1971-80	1981-90	1991-00	2001-10	2011-20	2021-30	1971-80	1981-90	1991-00	2001-10	2011-20	2021-30
OEL	15 mmol/	mol-1					5 mmol/n	nol-1				
Slovakia	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Slovenia	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Spain	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
Sweden	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
United Kingdom	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07
TOTAL	0.64	0.44	0.26	0.12	0.05	0.01	0.85	0.71	0.51	0.31	0.16	0.07



Table 8.3.2 Numbers and proportions of the population ever exposed for baseline and intervention^[1] scenarios (2) to (3), by country, men plus women

Scenario		yment a	and exp	osure Ì	l) - Line evel trer t therea	nds	lr com	ntervent	ion sce for OE	nario (2 L = 15 n) ^[2] – Fu nmol/m	II oI-1	Interve	ention s for C	cenario EL = 5			liance
Country	010 Number e	0707 Ver expo	sed in th	ne REP	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Austria	211	218	227	230	233	234	211	218	227	230	233	234	211	218	227	230	233	234
Belgium	182	189	198	203	206	208	182	189	198	203	206	208	182	189	198	203	206	208
Bulgaria	197	202	207	207	207	207	197	202	207	207	207	207	197	202	207	207	207	207
Cyprus	3	3	4	4	4	4	3	3	4	4	4	4	3	3	4	4	4	4
Czech Republic	600	617	638	643	646	648	600	617	638	643	646	648	600	617	638	643	646	648
Denmark	167	174	183	187	190	192	167	174	183	187	190	192	167	174	183	187	190	192
Estonia	39	39	41	41	41	41	39	39	41	41	41	41	39	39	41	41	41	41
Finland	133	138	144	147	149	150	133	138	144	147	149	150	133	138	144	147	149	150
France	1,780	1,729	1,681	1,639	1,583	1,562	1,780	1,729	1,681	1,639	1,583	1,562	1,780	1,729	1,681	1,639	1,583	1,562
Germany	2,909	3,020	3,162	3,227	3,274	3,302	2,909	3,020	3,162	3,227	3,274	3,302	2,909	3,020	3,162	3,227	3,274	3,302
Greece	99	105	114	120	124	127	99	105	114	120	124	127	99	105	114	120	124	127
Hungary	295	305	318	322	325	327	295	305	318	322	325	327	295	305	318	322	325	327
Ireland	68	71	75	77	78	79	68	71	75	77	78	79	68	71	75	77	78	79
Italy	1,514	1,563	1,623	1,642	1,655	1,663	1,514	1,563	1,623	1,642	1,655	1,663	1,514	1,563	1,623	1,642	1,655	1,663
Latvia	38	39	41	42	42	43	38	39	41	42	42	43	38	39	41	42	42	43
Lithuania	62	63	65	65	65	65	62	63	65	65	65	65	62	63	65	65	65	65



Scenario	emplo	yment	and exp	enario (oosure l constan	evel tre	nds		ntervent					Interv	ention s for C	cenario DEL = 5			oliance
Country	Number e	ver expo	osed in t	040 he REP	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Luxembourg	29	30	31	31	31	31	29	30	31	31	31	31	29	30	31	31	31	31
Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	301	322	351	374	391	401	301	322	351	374	391	401	301	322	351	374	391	401
Poland	973	999	1,029	1,032	1,034	1,035	973	999	1,029	1,032	1,034	1,035	973	999	1,029	1,032	1,034	1,035
Portugal	188	193	199	200	200	201	188	193	199	200	200	201	188	193	199	200	200	201
Romania	407	426	452	467	478	485	407	426	452	467	478	485	407	426	452	467	478	485
Slovakia	157	162	169	172	173	175	157	162	169	172	173	175	157	162	169	172	173	175
Slovenia	104	107	112	114	115	116	104	107	112	114	115	116	104	107	112	114	115	116
Spain	472	594	763	932	1,059	1,145	472	594	763	932	1,059	1,145	472	594	763	932	1,059	1,145
Sweden	229	235	241	241	241	241	229	235	241	241	241	241	229	235	241	241	241	241
United Kingdom	2,050	1,942	1,788	1,632	1,519	1,448	2,050	1,942	1,788	1,632	1,519	1,448	2,050	1,942	1,788	1,632	1,519	1,448
TOTAL	13,204	13,486	13,856	13,988	14,062	14,126	13,204	13,486	13,856	13,988	14,062	14,126	13,204	13,486	13,856	13,988	14,062	14,126



Scenario	emp	loymen	t and ex	posure	(1) - Lin level tro int there	ends		nterven					Interv		cenario DEL = 5			liance
Country	Propor	0 507 tion of th	ne popul	ation exp	oosed	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Austria	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%
Belgium	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%
Bulgaria	0.004%	0.004%	0.004%	0.004%	0.004%	0.005%	0.004%	0.004%	0.004%	0.004%	0.004%	0.005%	0.004%	0.004%	0.004%	0.004%	0.004%	0.005%
Cyprus	0.001%	0.001%	0.000%	0.000%	0.000%	0.000%	0.001%	0.001%	0.000%	0.000%	0.000%	0.000%	0.001%	0.001%	0.000%	0.000%	0.000%	0.000%
Czech Republic	0.008%	0.008%	0.008%	0.008%	0.008%	0.009%	0.008%	0.008%	0.008%	0.008%	0.008%	0.009%	0.008%	0.008%	0.008%	0.008%	0.008%	0.009%
Denmark	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%
Estonia	0.004%	0.004%	0.004%	0.004%	0.005%	0.005%	0.004%	0.004%	0.004%	0.004%	0.005%	0.005%	0.004%	0.004%	0.004%	0.004%	0.005%	0.005%
Finland	0.004%	0.003%	0.004%	0.004%	0.004%	0.004%	0.004%	0.003%	0.004%	0.004%	0.004%	0.004%	0.004%	0.003%	0.004%	0.004%	0.004%	0.004%
France	0.004%	0.004%	0.004%	0.003%	0.003%	0.003%	0.004%	0.004%	0.004%	0.003%	0.003%	0.003%	0.004%	0.004%	0.004%	0.003%	0.003%	0.003%
Germany	0.005%	0.005%	0.005%	0.005%	0.006%	0.006%	0.005%	0.005%	0.005%	0.005%	0.006%	0.006%	0.005%	0.005%	0.005%	0.005%	0.006%	0.006%
Greece	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%
Hungary	0.004%	0.004%	0.004%	0.004%	0.005%	0.005%	0.004%	0.004%	0.004%	0.004%	0.005%	0.005%	0.004%	0.004%	0.004%	0.004%	0.005%	0.005%
Ireland	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%
Italy	0.003%	0.003%	0.003%	0.003%	0.003%	0.004%	0.003%	0.003%	0.003%	0.003%	0.003%	0.004%	0.003%	0.003%	0.003%	0.003%	0.003%	0.004%
Latvia	0.002%	0.002%	0.003%	0.003%	0.003%	0.003%	0.002%	0.002%	0.003%	0.003%	0.003%	0.003%	0.002%	0.002%	0.003%	0.003%	0.003%	0.003%
Lithuania	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%
Luxembourg	0.008%	0.008%	0.007%	0.006%	0.006%	0.006%	0.008%	0.008%	0.007%	0.006%	0.006%	0.006%	0.008%	0.008%	0.007%	0.006%	0.006%	0.006%



Scenario	emp	loymen	t and ex	posure	(1) - Lin level tro int there	ends		ntervent npliance					Interv			(3) - Fu mmol/m		liance
Country	0107 Propor	0202 tion of th	05 ne popul	ation exp	5050 posed	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Malta	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Netherlands	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%	0.003%
Poland	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%
Portugal	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%
Romania	0.003%	0.003%	0.003%	0.003%	0.003%	0.004%	0.003%	0.003%	0.003%	0.003%	0.003%	0.004%	0.003%	0.003%	0.003%	0.003%	0.003%	0.004%
Slovakia	0.004%	0.004%	0.004%	0.004%	0.004%	0.005%	0.004%	0.004%	0.004%	0.004%	0.004%	0.005%	0.004%	0.004%	0.004%	0.004%	0.004%	0.005%
Slovenia	0.007%	0.007%	0.007%	0.007%	0.008%	0.008%	0.007%	0.007%	0.007%	0.007%	0.008%	0.008%	0.007%	0.007%	0.007%	0.007%	0.008%	0.008%
Spain	0.001%	0.002%	0.002%	0.002%	0.003%	0.003%	0.001%	0.002%	0.002%	0.002%	0.003%	0.003%	0.001%	0.002%	0.002%	0.002%	0.003%	0.003%
Sweden	0.004%	0.003%	0.003%	0.003%	0.003%	0.003%	0.004%	0.003%	0.003%	0.003%	0.003%	0.003%	0.004%	0.003%	0.003%	0.003%	0.003%	0.003%
United Kingdom	0.005%	0.004%	0.004%	0.003%	0.003%	0.003%	0.005%	0.004%	0.004%	0.003%	0.003%	0.003%	0.005%	0.004%	0.004%	0.003%	0.003%	0.003%
TOTAL	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%



Table 8.3.3 Results for baseline and intervention^[1] scenarios for bladder cancer, by country, men plus women

Scenario	emp	loymen	t and ex	posure	(1) - Lin level tre int there	ends		nterven					Interv			(3) - Fu mmol/n	ıll comp nol-1	liance
Country	0 700 Attribu	0202 table Fra	oction	2040	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Austria	0.006%	0.004%	0.003%	0.001%	0.001%	0.000%	0.006%	0.004%	0.003%	0.001%	0.000%	0.000%	0.006%	0.004%	0.003%	0.001%	0.000%	0.000%
Belgium	0.005%	0.004%	0.002%	0.001%	0.001%	0.000%	0.005%	0.004%	0.002%	0.001%	0.000%	0.000%	0.005%	0.004%	0.002%	0.001%	0.000%	0.000%
Bulgaria	0.005%	0.004%	0.003%	0.002%	0.001%	0.000%	0.005%	0.004%	0.003%	0.001%	0.001%	0.000%	0.005%	0.004%	0.003%	0.001%	0.000%	0.000%
Cyprus	0.002%	0.002%	0.002%	0.002%	0.002%	0.001%	0.002%	0.002%	0.002%	0.002%	0.002%	0.001%	0.002%	0.002%	0.002%	0.002%	0.001%	0.001%
Czech Republic	0.013%	0.011%	0.008%	0.004%	0.002%	0.001%	0.013%	0.011%	0.008%	0.004%	0.002%	0.000%	0.013%	0.011%	0.008%	0.004%	0.001%	0.000%
Denmark	0.006%	0.005%	0.003%	0.001%	0.001%	0.000%	0.006%	0.005%	0.003%	0.001%	0.000%	0.000%	0.006%	0.005%	0.003%	0.001%	0.000%	0.000%
Estonia	0.007%	0.006%	0.005%	0.003%	0.002%	0.001%	0.007%	0.006%	0.005%	0.003%	0.001%	0.001%	0.007%	0.006%	0.005%	0.003%	0.001%	0.000%
Finland	0.005%	0.004%	0.002%	0.001%	0.000%	0.000%	0.005%	0.004%	0.002%	0.001%	0.000%	0.000%	0.005%	0.004%	0.002%	0.001%	0.000%	0.000%
France	0.009%	0.007%	0.004%	0.002%	0.001%	0.000%	0.009%	0.007%	0.004%	0.002%	0.001%	0.000%	0.009%	0.007%	0.004%	0.002%	0.001%	0.000%
Germany	0.007%	0.006%	0.004%	0.002%	0.001%	0.000%	0.007%	0.006%	0.004%	0.002%	0.001%	0.000%	0.007%	0.006%	0.004%	0.002%	0.001%	0.000%
Greece	0.002%	0.001%	0.001%	0.000%	0.000%	0.000%	0.002%	0.001%	0.001%	0.000%	0.000%	0.000%	0.002%	0.001%	0.001%	0.000%	0.000%	0.000%
Hungary	0.007%	0.006%	0.004%	0.002%	0.001%	0.001%	0.007%	0.006%	0.004%	0.002%	0.001%	0.000%	0.007%	0.006%	0.004%	0.002%	0.001%	0.000%
Ireland	0.004%	0.003%	0.002%	0.001%	0.000%	0.000%	0.004%	0.003%	0.002%	0.001%	0.000%	0.000%	0.004%	0.003%	0.002%	0.001%	0.000%	0.000%
Italy	0.006%	0.004%	0.003%	0.002%	0.001%	0.000%	0.006%	0.004%	0.003%	0.001%	0.001%	0.000%	0.006%	0.004%	0.003%	0.001%	0.000%	0.000%
Latvia	0.003%	0.003%	0.002%	0.001%	0.001%	0.000%	0.003%	0.003%	0.002%	0.001%	0.000%	0.000%	0.003%	0.003%	0.002%	0.001%	0.000%	0.000%
Lithuania	0.004%	0.004%	0.003%	0.002%	0.001%	0.000%	0.004%	0.004%	0.003%	0.002%	0.001%	0.000%	0.004%	0.004%	0.003%	0.002%	0.001%	0.000%



Scenario	emp	loymen	t and ex	posure	(1) - Lin level tre nt there	ends) ^[2] – Fu nmol/m		Interv		cenario DEL = 5		ıll comp nol-1	liance
Country	010 Attribu	0 707 table Fra	020 action	2040	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Luxembourg	0.024%	0.023%	0.022%	0.020%	0.019%	0.018%	0.024%	0.023%	0.022%	0.020%	0.019%	0.018%	0.024%	0.023%	0.022%	0.020%	0.018%	0.017%
Malta	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Netherlands	0.003%	0.002%	0.001%	0.001%	0.000%	0.000%	0.003%	0.002%	0.001%	0.001%	0.000%	0.000%	0.003%	0.002%	0.001%	0.001%	0.000%	0.000%
Poland	0.007%	0.006%	0.004%	0.003%	0.002%	0.001%	0.007%	0.006%	0.004%	0.003%	0.001%	0.000%	0.007%	0.006%	0.004%	0.003%	0.001%	0.000%
Portugal	0.004%	0.003%	0.002%	0.001%	0.001%	0.000%	0.004%	0.003%	0.002%	0.001%	0.000%	0.000%	0.004%	0.003%	0.002%	0.001%	0.000%	0.000%
Romania	0.003%	0.003%	0.002%	0.001%	0.000%	0.000%	0.003%	0.003%	0.002%	0.001%	0.000%	0.000%	0.003%	0.003%	0.002%	0.001%	0.000%	0.000%
Slovakia	0.006%	0.005%	0.003%	0.002%	0.001%	0.000%	0.006%	0.005%	0.003%	0.002%	0.001%	0.000%	0.006%	0.005%	0.003%	0.002%	0.001%	0.000%
Slovenia	0.011%	0.009%	0.006%	0.003%	0.002%	0.001%	0.011%	0.009%	0.006%	0.003%	0.001%	0.000%	0.011%	0.009%	0.006%	0.003%	0.001%	0.000%
Spain	0.002%	0.002%	0.002%	0.001%	0.001%	0.000%	0.002%	0.002%	0.002%	0.001%	0.001%	0.000%	0.002%	0.002%	0.002%	0.001%	0.000%	0.000%
Sweden	0.005%	0.004%	0.002%	0.001%	0.000%	0.000%	0.005%	0.004%	0.002%	0.001%	0.000%	0.000%	0.005%	0.004%	0.002%	0.001%	0.000%	0.000%
United Kingdom	0.009%	0.007%	0.004%	0.002%	0.001%	0.000%	0.009%	0.007%	0.004%	0.002%	0.000%	0.000%	0.009%	0.007%	0.004%	0.002%	0.000%	0.000%
TOTAL	0.006%	0.005%	0.003%	0.002%	0.001%	0.000%	0.006%	0.005%	0.003%	0.002%	0.001%	0.000%	0.006%	0.005%	0.003%	0.002%	0.001%	0.000%



Scenario	emplo	yment a	and exp	osure le	1) - Line evel trer t therea	nds	Int com _l	tervention pliance	on scen for OEL	ario (2) [[] = 15 mi	^{2]} – Full mol/mol	-1	Interve	ntion sc for OE	enario (EL = 5 m	(3) - Full nmol/mo	compli I-1	ance
Country	010 Attributa	0 20 ble Deat	5030 hs	2040	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Austria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Belgium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Czech Republic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Denmark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Finland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greece	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hungary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Italy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Latvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithuania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Luxembourg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Scenario	emplo	eline (tre syment a ed to 20	nd exp	osure le	evel tren	ıds	Int comp	erventioniance	on scen for OEL	ario (2) [[] = 15 mi	^{2]} – Full mol/mol	-1	Interve	ntion sc for OE	enario (EL = 5 m	3) - Full imol/mo	compli ol-1	ance
Country	010 Attributa	07 505 ble Death	5030 1s	2040	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Romania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slovakia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slovenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sweden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
United Kingdom	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3	3	2	1	1	0	3	3	2	1	1	0	3	3	2	1	0	0



Scenario	emplo	yment a	end) scer and expo 21-30, co	sure le	evel trer	nds	Int com	tervention pliance	on scen for OEL	ario (2) [[] = 15 m	^{2]} – Full mol/mol	-1	Interve	ntion sc for Ol	enario (EL = 5 m	3) - Full imol/mo	complia ol-1	ance
Country	Attributa	0707 ble Regi	00 00 strations	2040	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Austria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Belgium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Czech Republic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Denmark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Finland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
France	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0
Germany	2	2	2	1	0	0	2	2	2	1	0	0	2	2	2	1	0	0
Greece	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hungary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Italy	1	1	1	1	0	0	1	1	1	0	0	0	1	1	1	0	0	0
Latvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithuania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Luxembourg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Scenario	emplo	yment a	end) scer and expo 21-30, co	sure le	evel trer	nds	Int com _l	erventioniance	on scen for OEL	ario (2) [[] = 15 m	^{2]} – Full mol/mol	-1	Interve			3) - Full nmol/mo		ance
Country	010 Attributa	07 07 ble Regi	000 Strations	2040	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poland	1	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0
Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Romania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slovakia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slovenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sweden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
United Kingdom	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0
TOTAL	8	8	6	3	2	1	8	8	6	3	1	0	8	8	6	3	1	0



Scenario	emplo	yment a	and exp	enario (1 osure le constan	evel trer	nds	Int comp	erventic oliance	on scen for OEL	ario (2) [[] = 15 m	^{2]} – Full mol/mol	-1	Interve	ntion sc for Ol	enario (EL = 5 m	3) - Full mol/mo	complia ol-1	ance
Country	010 Attributa	0707 ble Years	0 5030 s of Life	0 Lost (YL	5020 Ls)	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Austria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Belgium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Czech Republic	1	1	1	1	0	0	1	1	1	1	0	0	1	1	1	1	0	0
Denmark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Finland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
France	6	5	4	2	1	0	6	5	4	2	1	0	6	5	4	2	1	0
Germany	5	5	4	2	1	0	5	5	4	2	1	0	5	5	4	2	1	0
Greece	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hungary	1	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Italy	4	3	3	2	1	0	4	3	3	1	1	0	4	3	3	1	0	0
Latvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithuania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Luxembourg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Scenario Country	emplo	eline (tre syment a ed to 20	and exp	osure le	vel tren	nds	Int comp	erventic pliance	on scen for OEL	ario (2) [[] = 15 mi	^{2]} – Full mol/mol	-1	Intervention scenario (3) - Full compliance for OEL = 5 mmol/mol-1						
	010 Attributa	020 ble Year	020 s of Life	04 Lost (YL	7050 Ls)	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060	
Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Poland	3	3	2	2	1	1	3	3	2	2	1	0	3	3	2	2	1	0	
Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Romania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Slovakia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Slovenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Spain	1	1	2	1	1	0	1	1	2	1	1	0	1	1	2	1	1	0	
Sweden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
United Kingdom	5	4	3	1	1	0	5	4	3	1	0	0	5	4	3	1	0	0	
TOTAL	30	28	21	13	7	3	30	28	21	12	5	1	30	28	21	12	4	0	



Scenario Country	emp	loymen	rend) so t and ex 2021-30,	posure	level tre	ends	COI	nterven nplianc	tion sce e for OE	enario (2 EL = 15 i	2) ^[2] – Fu mmol/m	II ol-1	Intervention scenario (3) - Full compliance for OEL = 5 mmol/mol-1						
	2010 Attribu	2020 table Yea	2030 ars of Lif	2040 e Lived	2050 with Disa	2060 ability (D	2010 ALYs)	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060	
Austria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Austria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Belgium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Czech Republic	1	1	1	1	0	0	1	1	1	1	0	0	1	1	1	1	0	0	
Denmark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Finland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
France	7	6	4	3	1	1	7	6	4	3	1	0	7	6	4	3	1	0	
Germany	7	7	5	3	1	1	7	7	5	3	1	0	7	7	5	3	1	0	
Greece	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Hungary	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Italy	5	5	3	2	1	0	5	5	3	2	1	0	5	5	3	2	1	0	
Latvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Lithuania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Luxembourg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Netherlands	1	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	
Poland	3	3	3	2	1	1	3	3	3	2	1	0	3	3	3	2	1	0	



Scenario Country	emp	seline (t oloymen med to 2	t and ex	cposure	level tre	ends					2) ^[2] – Fu mmol/m	Intervention scenario (3) - Full compliance for OEL = 5 mmol/mol-1						
	2010 Attribu	2020 Itable Ye	2030 ars of Lit	2040 fe Lived	2050 with Disa	2060 ability (D	2010 ALYs)	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Romania	1	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0
Slovakia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slovenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	2	2	2	2	1	1	2	2	2	2	1	0	2	2	2	2	1	0
Sweden	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
United Kingdom	7	6	4	2	1	0	7	6	4	2	1	0	7	6	4	2	0	0
TOTAL	39	36	27	17	8	4	39	36	27	16	6	2	39	36	27	16	6	0

^[1] Intervention scenarios have been estimated assuming baseline exposure and employment levels [2] Change from 2010 in baseline scenario is due to trends in 'historic' (pre 2005) part of REP

Note: numbers and proportions ever exposed remain constant across the baseline and intervention scenarios



 Table 8.3.4
 Numbers and proportions of the EU population ever exposed, by industry, men plus women

Scenario	emplo	yment	end) so and ex d to 202 there	posure 21-30, d	level t	rends					2) ^[2] – F mmol/n						(3) - Fu nmol/m	
Industry Sector	Mund 2010	0707 er ever	00 exposed	l in the l	7090 7090 7090	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Manufacture of rubber and plastic products	9,338	9,390	9,446	9,325	9,222	9,174	9,338	9,390	9,446	9,325	9,222	9,174	9,338	9,390	9,446	9,325	9,222	9,174
Manufacture of machinery and other equipment n.e.c.	2,938	2,977	3,023	3,004	2,987	2,979	2,938	2,977	3,023	3,004	2,987	2,979	2,938	2,977	3,023	3,004	2,987	2,979
Research and equipment	929	1,119	1,387	1,658	1,853	1,974	929	1,119	1,387	1,658	1,853	1,974	929	1,119	1,387	1,658	1,853	1,974

Scenario	emplo	yment	and ex d to 20	posure	(1) - Li e level t constar	rends					2) ^[2] – F mmol/r			nterven pliance			` '	
Industry Sector	Propo	0202 rtion of	the pop	noitation	exposed	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Manufacture of rubber and plastic products	0.003%	0.002%	0.002%	0.002%	0.002%	0.002%	0.003%	0.002%	0.002%	0.002%	0.002%	0.002%	0.003%	0.002%	0.002%	0.002%	0.002%	0.002%
Manufacture of machinery and other equipment n.e.c.	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%
Research and equipment	0.000%	0.000%	0.000%	0.000%	0.000%	0.001%	0.000%	0.000%	0.000%	0.000%	0.000%	0.001%	0.000%	0.000%	0.000%	0.000%	0.000%	0.001%



Table 8.3.5 Occupational attributable fractions, deaths, registrations, YLLs and DALYs for lung cancer by industry, men plus women

Scenario	emplo	yment	end) so and ex d to 202 there	posure 21-30, c	level t	rends					2) ^[2] – Fi mmol/n				tion sco for OE			
Industry Sector	010 Attribut	0707 table Fra	020 ction	2040	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Manufacture of rubber and plastic products	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
Manufacture of machinery and other equipment n.e.c.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Research and equipment	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Scenario	employ	ine (tre /ment a sumed	ınd exp	osure 1-30, co	level tr	ends				ario (2) . = 15 m				erventi liance				
Industry Sector	010 Attribut	2070 Sable De	020 aths	2040	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Manufacture of rubber and plastic products	3	3	2	1	1	0	3	3	2	1	1	0	3	3	2	1	0	0
Manufacture of machinery and other equipment n.e.c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Research and equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Scenario	employ	yment a	and exp	osure 1-30, co	(1) - Lin level tro onstant	ends		erventic liance f						terventi oliance				
Industry Sector	0107 Attribut	0707 table Re	05 203 egistratio	2040 2040	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Manufacture of rubber and plastic products	8	8	6	3	2	1	8	8	6	3	1	0	8	8	6	3	1	0
Manufacture of machinery and other equipment n.e.c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Research and equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Scenario	emplo	yment a	and exp	osure 1-30, co	(1) - Line level tre onstant	ends		erventio liance f								nario (L = 5 m		
Industry Sector	010 Attribut	0 70 0 table Ye	05 ars of L	5040 ife Lost	(YLLs)	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Manufacture of rubber and plastic products	30	28	21	13	7	3	30	28	21	12	5	1	30	28	21	12	4	0
Manufacture of machinery and other equipment n.e.c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Research and equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Scenario	employ	line (tre yment a ssumed	and exp	osure ì 1-30, co	evel tr	ends			on scen for OEL					terventi oliance				
Industry Sector		0202 table Yea ity (DAL		07 ife Lived	d with	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Manufacture of rubber and plastic products	39	36	27	17	8	4	39	36	27	16	6	2	39	36	27	16	6	0
Manufacture of machinery and other equipment n.e.c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Research and equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

^[1] Intervention scenarios have been estimated assuming baseline exposure and employment levels

Note: numbers and proportions ever exposed remain constant across the baseline and intervention scenarios



^[2] Change from 2010 in baseline scenario is due to trends in 'historic' (pre 2005) part of REP

8.4 VALUING HEALTH BENEFITS – INTERVENTION SCENARIOS

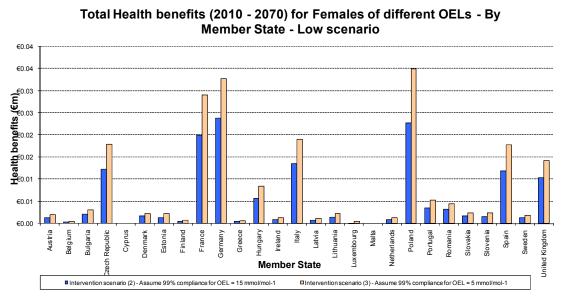


Figure 8.4.1 Total health benefits to females of introducing an EU wide OEL – By Member State – Low Scenario (Present Value – 2010 €m prices)



Total Health benefits (2010 - 2070) for Females of different OELs - By Member State - High scenario

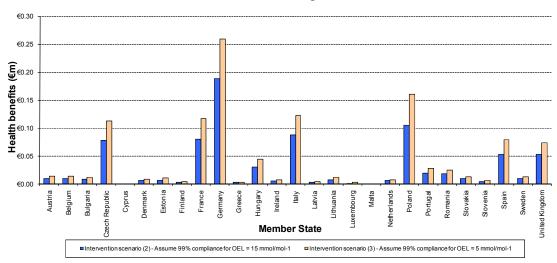


Figure 8.4.2 Total health benefits to females of introducing an EU wide OEL – By Member State – High Scenario (Present Value – 2010 €m prices)



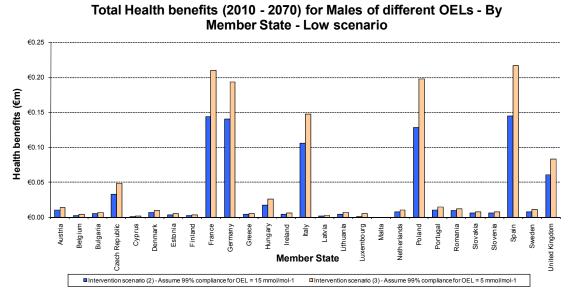


Figure 8.4.3 Total health benefits to males of introducing an EU wide OEL – By Member State – Low Scenario (Present Value – 2010 €m prices)



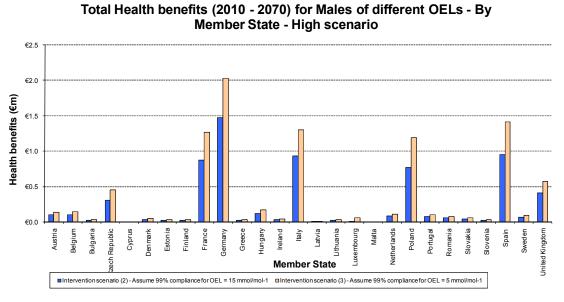


Figure 8.4.4 Total health benefits to males of introducing an EU wide OEL – By Member State – High Scenario (Present Value – 2010 €m prices)



8.5 HEALTH BENEFITS USING DIFFERENT DISCOUNT RATES

Key to tables

These values are calculated using no discount rate
These values are calculated using the EU IA guidance discount rate (4%)
These values are calculated using a declining discount rate (4% reducing to 3%)

Table 8.5.1 Introducing an BMGV of 15 μ mol/mol

MbOCA		Option 2	- Assume 9	9% complia	ance for OEI	L = 15 μmol/	mol
	Gender	2010- 2019	2020- 2029	2030- 2039	2040- 2049	2050- 2059	2060- 2069
	Females	0 to 0	0 to 0	0 to 0	0 to 1	0 to 2	0 to 2
	Males	0 to 0	0 to 0	0 to 0	1 to 6	2 to 16	3 to 20
Ē	Totals	0 to 0	0 to 0	0 to 0	1 to 6	3 to 18	3 to 22
costs (€m)	Gender	2010- 2019	2020- 2029	2030- 2039	2040- 2049	2050- 2059	2060- 2069
8	Females	0 to 0					
e of	Males	0 to 0	0 to 0	0 to 0	0 to 1	0 to 3	0 to 2
Range	Totals	0 to 0	0 to 0	0 to 0	0 to 2	0 to 3	0 to 3
Ra	Gender	2010- 2019	2020- 2029	2030- 2039	2040- 2049	2050- 2059	2060- 2069
	Females	0 to 0	0 to 0	0 to 0	0 to 0	0 to 1	0 to 0
	Males	0 to 0	0 to 0	0 to 0	0 to 2	1 to 4	1 to 4
	Totals	0 to 0	0 to 0	0 to 0	0 to 2	1 to 5	1 to 4



Member State	Low cost	High cost	Low cost	High cost	Low cost	High cost
Austria	€ 0.1	€ 0.7	€ 0.0	€ 0.1	€ 0.0	€ 0.2
Belgium	€ 0.0	€ 0.0	€ 0.0	€ 0.1	€ 0.0	€ 0.2
Bulgaria	€ 0.0	€ 0.1	€ 0.0	€ 0.0	€ 0.0	€ 0.0
Czech Republic	€ 0.3	€ 0.4	€ 0.1	€ 0.4	€ 0.1	€ 0.6
Cyprus	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0
Denmark	€ 0.1	€ 0.1	€ 0.0	€ 0.0	€ 0.0	€ 0.1
Estonia	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0
Finland	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0
France	€ 1.0	€ 1.2	€ 0.2	€ 1.0	€ 0.3	€ 1.5
Germany	€ 1.0	€ 1.2	€ 0.2	€ 1.7	€ 0.3	€ 2.6
Greece	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0
Hungary	€ 0.2	€ 0.2	€ 0.0	€ 0.1	€ 0.0	€ 0.2
Ireland	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.1
Italy	€ 0.8	€ 0.9	€ 0.1	€ 1.0	€ 0.2	€ 1.6
Latvia	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0
Lithuania	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0
Luxembourg	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0
Malta	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0
Netherlands	€ 0.1	€ 0.1	€ 0.0	€ 0.1	€ 0.0	€ 0.1
Poland	€ 1.0	€ 1.2	€ 0.2	€ 0.9	€ 0.2	€ 1.4
Portugal	€ 0.1	€ 0.1	€ 0.0	€ 0.1	€ 0.0	€ 0.1
Romania	€ 0.1	€ 0.1	€ 0.0	€ 0.1	€ 0.0	€ 0.1
Slovakia	€ 0.0	€ 0.1	€ 0.0	€ 0.1	€ 0.0	€ 0.1
Slovenia	€ 0.0	€ 0.1	€ 0.0	€ 0.0	€ 0.0	€ 0.0
Spain	€ 1.0	€ 1.2	€ 0.2	€ 1.0	€ 0.2	€ 1.6
Sweden	€ 0.1	€ 0.1	€ 0.0	€ 0.1	€ 0.0	€ 0.1
United Kingdom	€ 0.5	€ 0.5	€ 0.1	€ 0.5	€ 0.1	€ 0.7

Industry Group	Low	High	Low	High	Low	High
	cost	cost	cost	cost	cost	cost
Manufacture of rubber and						
plastic products	€ 6.4	€ 47.0	€ 1.0	€ 7.4	€ 1.6	€ 11.6
Manufacture of machinery						
and other equipment n.e.c.	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0
Research and equipment	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0



Table 8.5.2 Introducing an BMGV of 5 μ mol/mol

MbOCA		Opt	ion 2 - Assu	ıme 99% co	mpliance fo	r OEL = 5 µn	nol/mol
	Gender	2010- 2019	2020- 2029	2030- 2039	2040- 2049	2050- 2059	2060- 2069
	Females	0 to 0	0 to 0	0 to 0	0 to 1	0 to 3	1 to 4
	Males	0 to 0	0 to 0	0 to 0	1 to 7	3 to 23	4 to 32
<u>_</u>	Totals	0 to 0	0 to 0	0 to 0	1 to 8	4 to 25	5 to 36
costs (€m)	Gender	2010- 2019	2020- 2029	2030- 2039	2040- 2049	2050- 2059	2060- 2069
ő	Females	0 to 0					
e of	Males	0 to 0	0 to 0	0 to 0	0 to 2	1 to 4	0 to 4
Range	Totals	0 to 0	0 to 0	0 to 0	0 to 2	1 to 4	1 to 4
Re	Gender	2010- 2019	2020- 2029	2030- 2039	2040- 2049	2050- 2059	2060- 2069
	Females	0 to 0	0 to 0	0 to 0	0 to 0	0 to 1	0 to 1
	Males	0 to 0	0 to 0	0 to 0	0 to 3	1 to 6	1 to 6
	Totals	0 to 0	0 to 0	0 to 0	0 to 3	1 to 7	1 to 7



Member State	Low cost	High cost	Low cost	High cost	Low cost	High cost
Austria	€ 0.1	€ 0.1	€ 0.0	€ 0.1	€ 0.0	€ 0.2
Belgium	€ 0.0	€ 0.0	€ 0.0	€ 0.2	€ 0.0	€ 0.3
Bulgaria	€ 0.1	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.1
Czech Republic	€ 0.5	€ 0.3	€ 0.1	€ 0.6	€ 0.1	€ 0.9
Cyprus	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0
Denmark	€ 0.1	€ 0.0	€ 0.0	€ 0.1	€ 0.0	€ 0.1
Estonia	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.1
Finland	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.1
France	€ 1.6	€ 0.8	€ 0.2	€ 1.4	€ 0.4	€ 2.2
Germany	€ 1.5	€ 0.7	€ 0.2	€ 2.3	€ 0.4	€ 3.6
Greece	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.1
Hungary	€ 0.2	€ 0.1	€ 0.0	€ 0.2	€ 0.1	€ 0.3
Ireland	€ 0.0	€ 0.0	€ 0.0	€ 0.1	€ 0.0	€ 0.1
Italy	€ 1.1	€ 0.6	€ 0.2	€ 1.4	€ 0.3	€ 2.2
Latvia	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0
Lithuania	€ 0.1	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.1
Luxembourg	€ 0.0	€ 0.0	€ 0.0	€ 0.1	€ 0.0	€ 0.1
Malta	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0
Netherlands	€ 0.1	€ 0.0	€ 0.0	€ 0.1	€ 0.0	€ 0.2
Poland	€ 1.5	€ 0.8	€ 0.2	€ 1.3	€ 0.4	€ 2.1
Portugal	€ 0.1	€ 0.1	€ 0.0	€ 0.1	€ 0.0	€ 0.2
Romania	€ 0.1	€ 0.1	€ 0.0	€ 0.1	€ 0.0	€ 0.2
Slovakia	€ 0.1	€ 0.0	€ 0.0	€ 0.1	€ 0.0	€ 0.1
Slovenia	€ 0.1	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.1
Spain	€ 1.6	€ 0.8	€ 0.2	€ 1.5	€ 0.4	€ 2.4
Sweden	€ 0.1	€ 0.0	€ 0.0	€ 0.1	€ 0.0	€ 0.2
United Kingdom	€ 0.6	€ 0.3	€ 0.1	€ 0.6	€ 0.2	€ 1.0

Industry Group	Low	High	Low	High	Low	High
	cost	cost	cost	cost	cost	cost
Manufacture of rubber and plastic products	€ 9.5	€ 69.6	€ 1.5	€ 10.6	€ 2.3	€ 16.8
Manufacture of machinery and other equipment nec	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0
Research and equipment	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0	€ 0.0



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