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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

Respirable crystalline silica

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SUMMARY

Crystalline silica, inhaled in the form of quartz or cristobalite from occupational sources has been classified as a group 1 carcinogen (Carcinogenic to humans) by the International Agency for Research on Cancer (IARC). It is not currently included within the scope of the Carcinogens Directive. The key objectives of the present study are to identify the technical feasibility and the socioeconomic, health and environmental impacts of setting an OEL for respirable crystalline silica of 0.05, 0.1 or 0.2 mg/m³.

Crystalline silica is abundant in rocks, sands and soils and exposure to respirable crystalline silica (RCS) occurs in many industries. Common exposure scenarios include earth moving (eg. mining, quarrying, tunnelling), crushing or grinding of silica containing material such as concrete, aggregate or mortar, the manufacture of glass and other non-metallic mineral products and use of sand as moulding media in foundries. We estimate that approximately 5 300 000 employees in the EU were potentially exposed to RCS in 2006. Over 4 million of these workers are in the construction industry.

The estimated overall weighted geometric mean exposure across all countries and industries is 0.07 mg/m³ with a GSD of 5.2. The sectors with the highest estimated mean exposure (0.09 mg/m³) are construction and the electricity, gas, steam and hot water supply industries. The percentages of workers currently exposed to concentrations greater than 0.05, 0.1 and 0.2 mg/m³ in the construction sector are estimated as 63%, 48% and 32%, respectively. Mean exposure concentrations in most other sectors are less than 0.03 mg/m³ with the exception of non-metallic mineral products (0.045 mg/m³). The findings of an earlier IOM study indicate that exposure concentrations have fallen by about 7% per year over the past 20 – 30 years.

We estimate that in 2010 in the EU there will be about 6,870 deaths from lung cancer and 7,645 registrations that might be attributable to past exposure to RCS, which corresponds to about 2.45% of all lung cancer deaths amongst the exposed workers. If no specific actions are taken to reduce exposure to RCS, based on the assumption that current trends in employment and exposure are maintained until 2030 and remain steady thereafter, the predicted numbers of lung cancer deaths in 2060 attributable to RCS would be 5,685 with a predicted 72,091 years loss of life expectancy (YLLs) or 73,394 DALYS and 5,824 registrations. The lung cancers that might be attributable to RCS would have reduced to 1.265% of all lung cancer deaths in the exposed population.

The introduction of an OEL of 0.05 mg/m³ would lead to reductions in the number of predicted lung cancer deaths and registrations in 2060 to 337 and 345 respectively corresponding to 4,151 YLLs or 4,347 DALYS. The introduction of an OEL of 0.1 mg/m³ would lead to reductions in the number of predicted lung cancer deaths and registrations in 2060 to 818 and 838 respectively corresponding to 10,089 YLLs or 10,565 DALYS. The introduction of an OEL of 0.2 mg/m³ would lead to reductions in the number of predicted lung cancer deaths and registrations in 2060 to 1,721 and 1,763 respectively corresponding to 21,217 YLLs or 22,217 DALYS. The number of “avoided” cancers associated with the introduction of an OEL of 0.05, 0.1 or 0.2 mg/m³ would be 5,479, 4,985 and 4,061 respectively.

The total net health benefits accrued by 2069 from setting an OEL at 0.05 mg/m³ are estimated to be between €27,858m and €74,096. The benefits associated with an OEL of 0.1 mg/m³ are estimated to be between €25,522m and €67,921m and the benefits associated with an OEL of 0.2 mg/m³ are estimated to be between €21,171m and €56,393m. As most of the benefits are not realised until after 2040, the level of discounting has a substantial impact on estimated benefits. The biggest benefits arise in the construction sector.

The estimated costs of compliance are thought to be lower or within the range of the estimated benefits, indicating that the benefits of introducing an OEL may outweigh the costs of compliance. The total costs of compliance over the period 2010-2069 with an OEL of 0.05mg/m³ are estimated to be €34bn over the period 2010-2069. The greatest costs are predicted to fall on the construction sector (€17bn) given the the number of enterprises thought to be affected (around 485,000). The compliance costs for an OEL of 0.1mg/ m³ are estimated to be substantially lower at €19bn over the same period. The greatest costs, €13 bn, would fall on the construction sector because of the large number of affected enterprises (around 370,000). The estimated costs of compliance with an OEL of 0.2 mg/m³ are estimated to be €10bn with €8n falling on the construction sector (around 250,000 enterprises affected).

The majority of the companies that would be affected by the imposition of an OEL are small and the costs of meeting an OEL of 0.05 or 0.1 mg/m³ may be very expensive for a large proportion of the affected sectors. This may lead to some company closures and, for industries for which relocation is possible, some relocation of activities to outside of the EU. The imposition of an OEL of 0.2 mg/m³ would not be expected to have such a significant adverse impact on small businesses.

No significant environmental impacts would be anticipated following any increase in emissions of silica to ambient air as a result of improved workplace controls. The increased use of local exhaust ventilation (LEV), however, in order to achieve an OEL could lead to increased fossil fuel consumption and greenhouse emissions.

1 PROBLEM DEFINITION

1.1 OUTLINE OF THE INVESTIGATION

Exposure to respirable crystalline silica in workplace air is associated with the development of silicosis, an irreversible chronic respiratory illness and lung cancer. Crystalline silica, inhaled in the form of quartz or cristobalite from occupational sources has been classified as a group 1 carcinogen (Carcinogenic to humans) by IARC.¹ In this assessment we consider the impacts of reducing exposure to respirable crystalline silica as a consequence of including it in the definition of a carcinogen in the revised Directive.

The key objectives of the present study are to identify the technical feasibility and the socioeconomic, health and environmental impacts of setting an OEL for respirable crystalline silica of 0.05, 0.1 or 0.2 mg/m³.

1.2 OELS/EXPOSURE CONTROL

Existing national occupational exposure limits (OELs) for quartz, cristobalite and tridymite in EU member states are presented in Table 1.1. These are expressed as long-term limits, averages over an 8-hour working day OELs from selected countries outside the EU are also presented for comparison. For the purposes of this report respirable crystalline silica OELs of 0.05, 0.1 or 0.2 mg/m³ are considered typical for the EU.

Table 1.1 Occupational exposure limits for respirable crystalline silica (quartz, cristobalite and tridymite) in EU Member States

Country	OEL - long-term (mg/m ³)			
	Quartz	Cristobalite	Tridymite	
Austria	0.15		0.15	0.15
Belgium	0.1		0.05	0.05
Bulgaria	0.07		0.07	0.07
Czech Republic	0.1		0.1	0.1
Cyprus	10k/Q ^[1]		-	-
Denmark	0.1		0.05	0.05
Estonia	0.1		0.05	0.05
Finland	0.2		0.1	0.1
France	0.1		0.05	0.05
Germany	As low as reasonably achievable		0.15	0.15
Greece	0.1		0.05	0.05
Hungary	0.15		0.1	0.15
Ireland	0.05		0.05	0.05
Italy	0.05		0.05	0.05
Lithuania	0.1		0.05	0.05
Luxembourg	0.15		0.15	0.15

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

Country	OEL - long-term (mg/m ³)			
	Quartz	Cristobalite	Tridymite	
Malta	none	none	none	none
Netherlands	0.075	0.075	0.075	0.075
Norway	0.1	0.05	0.05	0.05
Poland	0.3	0.3	0.3	0.3
Portugal	0.05	0.05	0.05	0.05
Romania	0.1	0.05	0.05	0.05
Slovakia	0.1	0.1	0.1	0.1
Slovenia	0.15	0.15	0.15	0.15
Spain	0.1	0.05	0.05	0.05
Sweden	0.1	0.05	0.05	0.05
Switzerland	0.15	0.15	0.15	0.15
UK	0.1	0.1	0.1	0.1

^[1] Q: quartz percentage – K = 1

Source: http://www.ima-eu.org/fileadmin/eurosil_new/pdf/OEL-FULL-TABLE-Oct07-Europe.pdf

1.3 DESCRIPTION OF DIFFERENT USES

Silica (SiO₂) in its various forms is amongst the commonest minerals in the Earth's crust. Both amorphous and crystalline forms of silica occur in nature but the crystalline forms are more stable and therefore more abundant. Crystalline silica also occurs in a number of naturally occurring forms, the most common of which are quartz, cristobalite and tridymite. The respirable fraction of crystalline silica dust, which is small enough to reach the gas exchange region of the lungs upon inhalation (approximately 5 micrometers or less in diameter), is associated with silicosis and lung cancer among humans.

Crystalline silica is abundant in rocks, sands and soils and so exposure to respirable crystalline silica (RCS) occurs in many industries. Common scenarios in which RCS exposure occurs include the following:

- Movement of earth (eg. mining, quarrying, tunnelling);
- Crushing or grinding of silica containing material such as concrete, aggregate or mortar;
- Sandblasting;
- Use of silica, sand or silica containing products in the manufacture of glass and other non-metallic mineral products; and
- Use of sand as moulding media in foundries.

1.4 RISKS TO HUMAN HEALTH

1.4.1 Introduction

Exposure to respirable crystalline silica in workplace air is associated with the development of silicosis, an irreversible scarring disease of the lung and lung cancer. Silicosis appears to be a risk factor for the development of lung cancer.

1.4.2 Summary of the available epidemiological literature on risk

There have been a large number of epidemiological studies of exposure to respirable crystalline silica (RCS) and the risk of lung cancer, including in mining (coal and diatomaceous earth), the granite, stone and quarrying industries, foundries, the pottery industry, in brick making and in the silica and industry. Two issues of concern when interpreting studies of RCS and lung cancer are whether there has been adjustment for smoking and whether account has been taken of potential concomitant exposures e.g. asbestos, radon, coal dust etc. The risk of lung cancer has been shown to be consistently increased in silicotics (IARC, 1997, Steenland and Stayner, 1997). For the IARC evaluation nine studies were considered because they provided the least confounded examinations of an association between silica exposure and cancer risk (Burgess *et al*, 1997, Checkoway *et al*, 1993, Checkoway *et al*, 1996, Chen *et al*, 1992, Cherry *et al*, 1997, Costello and Graham, 1988, Costello *et al*, 1995, Dong *et al*, 1995, Guenel *et al*, 1989, McDonald *et al*, 1997, McLaughlin *et al*, 1992, Merlo *et al*, 1991, Winter *et al*, 1990). In making their overall evaluation, the IARC Working Group noted that carcinogenicity in humans was not detected in all industrial circumstances studied, and may be dependent on inherent characteristics of the crystalline silica or on external factors affecting its biological activity or distribution of its polymorphs.

Since the IARC (1997) monograph many more papers have been published of lung cancer risk in industries with and without confounding exposures that have added to the weight of evidence. In addition a number of reviews, meta-analyses and a pooled analysis have been undertaken reaffirming this classification.

Since 1997 there have been seven meta-analyses published. Tsuda *et al* (1997) examined the relationship between silicosis/pneumoconiosis and lung cancer mortality in 32 eligible studies published between 1980 and 1994. In all of these studies an excess of lung cancer mortality was observed. Using a random effects model the combined RR was 2.76 (95%CI=2.41-3.16), with similar results for both cohort and case-control studies. Although a majority of the studies did not adjust for smoking, those that did observed no difference between crude and adjusted estimates.

Steenland and Stayner (1997) carried out a review of 19 cohort and case-control studies of silicotics published between 1966 and 1995. They omitted studies in mines and foundries which, they stated, might involve confounding exposures, autopsy and proportional mortality studies. The summary RR for these studies was 2.3 (95%CI=2.2-2.6).

Finkelstein (2000) reviewed eight studies that provided quantitative information about silica exposure and the risk of silicosis and lung cancer, published between 1989 and 1999. Lung cancer RR increased with cumulative exposure (lagged 15-20 years), each relative risk being significant, up to 1.74 (95%CI=1.65-1.82) in the highest exposure group. A review of 31 studies published between 1966 and 2004 (Lacasse *et al*, 2005) found an unadjusted combined risk of 2.45 (95%CI=1.63-3.66) for the cohort studies. In cohorts for which mortality were adjusted for smoking the CRR was 1.60 (95%CI=1.33-1.93). When the results of the cohorts were restricted to never-smokers, the pooled SMR was 1.52 (95%CI=1.02-2.26). When studies of underground miners were excluded, thereby reducing the possibility of confounding by radon exposure, the CRR was 2.47 (95%CI=1.76-3.48). Lung cancer risk was analysed by radiological severity of silicosis, as a surrogate for 'dose'. For simple silicosis, for one category increments

the risk of lung cancer increased by 1.33 (95%CI=1.16-1.53). For complicated silicosis the risk increased by 1.67 (95%CI=1.52-1.83).

A recent meta-analysis estimated the RRs of lung cancer due to silica and silicosis from 30 studies published between 1966 and 2001 (Kurihara and Wada, 2004). Studies were excluded if the effects of asbestos and radioactive materials including radon were not adjusted for. Using a random-effects model the combined relative risk of lung cancer RRs was 1.32 (95%CI=1.23–1.41) in subjects exposed to RCS, 2.37 (95%CI=1.98–2.84) in silicotics only (based on 16 studies), and 0.96, (95%CI=0.81–1.15), (based on eight studies) in non-silicotics with exposure to silica. Lung cancer risk in silicotics who were also smokers was estimated to be 4.47 (95%CI=3.17-6.30) compared to 2.24 (95%CI=1.46-3.43) in non-smoking silicotics.

A review by Pelucchi *et al* (2006) included 28 cohort, 15 case-control and two PMR studies published between 1996 and July 2005. Using a random-effects model the pooled RR from all cohort studies was 1.34 (95%CI=1.25-1.45). Table 1.2 gives results for cohort and case-control studies separately and for different industry sectors. Combined relative risk among ceramics, DE and refractory brick workers, and miscellaneous exposure, were similar for both cohort and case-control studies. However, the pooled relative risk for miners was slightly higher in case-control studies than in cohort studies.

Table 1.2 Pooled RRs according to occupational setting, undefined silicosis status

Occupational group	Cohort studies	Case-control studies
Miners (underground & surface)	1.17 (1.03-1.32)	1.47 (1.19-1.82)
Sand workers	1.29 (1.03-1.61)	
Ceramics, diatomaceous earth & refractory brick workers	1.40 (1.11-1.75)	1.26 (0.99-1.62)
Miscellaneous exposure	1.17 (1.12-1.22)	1.24 (1.02-1.52)

Source: Pelucchi *et al* (2006)

In addition to the meta-analyses, a pooled analysis of data from 10 silica-exposed cohorts published between 1988 and 2000 that had quantitative exposure data has been carried out (Steenland *et al*, 2001). The pooled cohort included 65,980 workers (44,160 miners, 21,820 non-miners), and 1,072 lung cancer deaths (663 miners, 409 non-miners). The combined SMR for all the studies was 1.2 (95%CI=1.1-1.3). Log of cumulative exposure, with a 15-year lag, was a strong predictor of lung cancer ($p=0.0001$), with consistency across studies. Table 1.3 compares the exposure-response relationship between miners and non-miners, and shows slight differences in lung cancer risk at the lower end of exposures (Table 1.3).

Table 1.3 Lung cancer risk by cumulative RCS exposure for miners and non-miners

Cumulative exposure (mg/m ³ -years)	All cohorts	Miners	Non-miners
<0.4	1.0	1.0	1.0
0.4-2.0	1.0 (0.85-1.3)	0.9 (0.66-1.2)	1.2 (0.92-1.6)
2.0-5.4	1.3 (1.1-1.7)	0.81 (0.59-1.1)	2.1 (1.6-2.8)
5.4-12.8	1.5 (1.2-1.9)	1.2 (0.89-1.6)	1.7 (1.2-2.4)
12.8+ (median 28.0)	1.6 (1.3-2.1)	1.4 (1.0-1.9)	1.5 (0.97-2.4)

Source: Steenland *et al* (2001)

Excess lifetime risk, through age 75, for a worker exposed from age 20 to 65 at 0.1 mg/m³ RCS was estimated to be 1.1-1.7% above background risks of 3-6%.

1.4.3 Choice of risk estimates to assess health impact

The meta-analysis by Kurihara and Wada (2004) of 17 cohorts and 13 case-control studies published between 1966 and 2001 that examined the relationship between silica, silicosis and lung cancer gave a meta-RR of 1.32 (95%CI 1.24-1.41), similar to that of Pelucchi *et al* (2006). This has been used for the high and medium exposure groups of construction and potteries, Pelucchi's estimate of 1.17 (1.12, 1.22) has been used for mining and selected industry sectors and an RR of 1 has been used for the background group from the study by Steenland (2001) that found no excess at the lowest exposure levels.

2 BASELINE SCENARIOS

2.1 STRUCTURE OF THE SECTOR

Crystalline silica is used in a number of applications across a wide range of industry sectors. For the purposes of assessing the socio-economic impacts of an EU wide OEL for the sectors affected, there is a need for detailed information. Therefore for the purposes of this study, Eurostat data for certain (sub) sectors that have been identified² to have workers exposed to RCS have been used. These are set out in Table 2.1 below.

Table 2.1 Sectors from Eurostat considered for this study

Sector	NACE Code (v.1)	Description
Mining of metal ores	13	This division includes mining for metallic minerals (ores), performed through underground or open-cast extraction, seabed mining etc. Also included are ore dressing and beneficiating operations, such as crushing, grinding, washing, drying, sintering, calcining or leaching ore, gravity separation or flotation operations.

² Sectors were identified using CAREX data and data from HSE (2003) report; see Section 2.2

Sector	NACE Code (v.1)	Description
Quarrying of Stone	14.1	<p>This class includes:</p> <ul style="list-style-type: none"> - quarrying, rough trimming and sawing of monumental and building stone such as marble, granite, sandstone etc. - breaking and crushing of ornamental and building stone - quarrying, crushing and breaking of limestone - mining of gypsum and anhydrite - mining of chalk and uncalcined dolomite
Mining of chemical and fertiliser minerals	14.3	<p>This class includes:</p> <ul style="list-style-type: none"> - mining of natural phosphates and natural potassium salts - mining of native sulphur - extraction and preparation of pyrites and pyrrhotite, except roasting - mining of natural barium sulphate and carbonate (barytes and witherite), natural borates, natural magnesium sulphates (kieserite) - mining of earth colours, fluorspar and other minerals valued chiefly as a source of chemicals, - guano mining
Production of salt	14.4	<p>This class includes:</p> <ul style="list-style-type: none"> - extraction of salt from underground including by dissolving and pumping - salt production by evaporation of sea water or other saline waters - crushing, purification and refining of salt by the producer <p>This class excludes:</p> <ul style="list-style-type: none"> - processing of salt into food-grade salt, e.g. iodised salt, - potable water production by evaporation of saline water,
Other mining and quarrying n.e.c.	14.5	<p>This class includes the mining and quarrying of various minerals and materials:</p> <ul style="list-style-type: none"> - abrasive materials, asbestos, siliceous fossil meals, natural graphite, steatite (talc), feldspar etc. - natural asphalt, asphaltites and asphaltic rock; natural solid bitumen - gemstones, quartz, mica etc.
Construction	45	<p>This class encompasses all forms of construction, including:</p> <ul style="list-style-type: none"> construction of buildings, civil engineering works, specialised construction activities

Sector	NACE Code (v.1)	Description
Manufacture of basic metals	27	<p>This division includes the activities of smelting and/or refining ferrous and non-ferrous metals from ore, pig or scrap, using electrometallurgic and other process metallurgic techniques.</p> <p>This division also includes the manufacture of metal alloys and super-alloys by introducing other chemical elements to pure metals.</p>
Manufacture of fabricated metal products, except machinery and equipment	28	<p>This division includes the manufacture of “pure” metal products (such as parts, containers and structures), usually with a static, immovable function, as opposed to the following divisions 26-30, which cover the manufacture of combinations or assemblies of such metal products (sometimes with other materials) into more complex units that, unless they are purely electrical, electronic or optical, work with moving parts. The manufacture of weapons and ammunition is also included in this division.</p>
Manufacture of machinery and equipment n.e.c.	29	<p>This division includes the manufacture of machinery and equipment that act independently on materials either mechanically or thermally or perform operations on materials (such as handling, spraying, weighing or packing), including their mechanical components that produce and apply force, and any specially manufactured primary parts. This includes the manufacture of fixed and mobile or hand-held devices, regardless of whether they are designed for industrial, building and civil engineering, agricultural or home use. The manufacture of special equipment for passenger or freight transport within demarcated premises also belongs within this division.</p>
Manufacture of other transport equipment	35	<p>This division includes the manufacture of transportation equipment such as ship building and boat manufacturing, the manufacture of railroad rolling stock and locomotives, air and spacecraft and the manufacture of parts thereof.</p>
Manufacture of non-refractory ceramic goods	26.2	<p>This class includes manufacture of non-refractory ceramic goods other than for construction purposes.</p>
Manufacture of ceramic tiles and flags	26.3	<p>This class includes manufacture of non-refractory ceramic hearth or wall tiles, mosaic cubes etc.</p>
Manufacture of bricks, tiles and construction products, in baked clay	26.4	<p>This class includes:</p> <ul style="list-style-type: none"> - manufacture of structural non-refractory clay building materials: - manufacture of ceramic bricks, roofing tiles, chimney pots, pipes, conduits etc. - manufacture of flooring blocks in baked clay

Sector	NACE Code (v.1)	Description
Quarrying of sand and clay	14.2	<p>This class includes:</p> <ul style="list-style-type: none"> - extraction and dredging of industrial sand, sand for construction and gravel - breaking and crushing of gravel - quarrying of sand - mining of clays, refractory clays and kaolin <p>This class excludes:</p> <ul style="list-style-type: none"> - mining of bituminous sand,
Manufacture of other non-metallic mineral products (includes abrasive products)	26.8	<p>This group includes the manufacture of other non-metallic mineral products, including abrasive products.</p>
Manufacture of glass and glass products	26.1	<p>This group includes glass in all its forms, made by any process, and articles of glass.</p>
Manufacture of cement, lime and plaster	26.5	<p>This class includes:</p> <ul style="list-style-type: none"> - manufacture of clinkers and hydraulic cements, including Portland, aluminous cement, slag cement and superphosphate cements - manufacture of quicklime, slaked lime and hydraulic lime - manufacture of plasters of calcined gypsum or calcined sulphate
Manufacture of articles of concrete, plaster and cement	26.6	<p>This class includes:</p> <ul style="list-style-type: none"> - manufacture of precast concrete, cement or artificial stone articles for use in construction (tiles, flagstones, bricks, boards, sheets, panels, pipes, posts etc.) - manufacture of prefabricated structural components for building or civil engineering of cement, concrete or artificial stone
Manufacture of jewellery and related articles	36.2	<p>This class includes:</p> <ul style="list-style-type: none"> - production of worked pearls - production of precious and semi-precious stones in the worked state, including the working of industrial quality stones and synthetic or reconstructed precious or semi-precious stones - working of diamonds - manufacture of jewellery of precious metal or of base metals clad with precious metals, or precious or semi-precious stones, or of combinations of precious metal and precious or semi-precious stones or of other materials - manufacture of goldsmiths' articles of precious metals or of base metals clad with precious metals: - dinnerware, flatware, hollowware, toilet articles, office or desk articles, articles for religious use etc. - manufacture of technical or laboratory articles of precious metal (except instruments and parts thereof): crucibles, spatulas, electroplating anodes etc. - manufacture of precious metal watch bands, wristbands, watch straps and cigarette cases - engraving of personal precious and non-precious metal products

Sector	NACE Code (v.1)	Description
Cutting, shaping and finishing of stone	26.7	<p>This class includes:</p> <ul style="list-style-type: none"> - cutting, shaping and finishing of stone for use in construction, in cemeteries, on roads, as roofing etc. - manufacture of stone furniture <p>This class excludes:</p> <ul style="list-style-type: none"> - activities carried out by operators of quarries, e.g. production of rough cut stone, - production of millstones, abrasive stones and similar products,
Electricity, gas, steam and hot water supply	40	<p>This class includes:</p> <ul style="list-style-type: none"> - the generation of bulk electric power, transmission from generating facilities to distribution centres and distribution to end users. - the manufacture of gas and the distribution of natural or synthetic gas to the consumer through a system of mains, - production, collection and distribution of steam and hot water for heating, power and other purposes

All sectors in Table 2.1, with the exception of the electricity supply sector, were eventually used in the latter analysis given our assumption (based on the Eurostat sector descriptors) that workers employed in these sectors are more likely to be exposed to RCS. We recognise that the number of workers and enterprises affected by the proposed reduction in the OEL are likely to be an overestimate since the NACE codes include activities in which workers may not necessarily be exposed to RCS.

In the absence of any more precise or comprehensive publicly available data, the Eurostat data was considered suitable for this study. Table 2.2 shows the turnover, number of persons employed, total number of enterprises and the proportion of enterprises in each size class for the EU-27 in 2006.

Table 2.2 Statistics of the sectors used in this study

Sector	NACE code	Turnover (€m)	Number of Persons employed	Number of enterprises	% by size category (no. employees)				
					1-9	10-19	20-49	50-250	>250
Mining of metal ores	13	7,785	22,715	316	76	5	7	3	9
Quarrying of Stone	14.1	8,400	68,655	5,767	76	13	8	3	0
Quarrying of sand and clay	14.2	28,147	141,564	9,073	68	18	11	3	0
Mining of chemical and fertiliser minerals	14.3	608	3,623	142	82	11	4	3	1
Production of salt	14.4	1,503	10,310	501	91	3	4	1	1

Sector	NACE code	Turnover (€m)	Number of Persons employed	Number of enterprises	% by size category (no. employees)				
					1-9	10-19	20-49	50-250	>250
Other mining and quarrying n.e.c.	14.5	2,159	13,010	763	74	13	8	5	0
Manufacture of glass and glass products	26.1	44,419	369,879	17,370	80	9	5	5	2
Manufacture of non-refractory ceramic goods	26.2	16,475	190,561	16,044	89	5	3	3	1
Manufacture of ceramic tiles and flags	26.3	13,022	88,221	1,754	54	14	13	16	4
Manufacture of bricks, tiles and construction products, in baked clay	26.4	10,371	79,036	2,672	64	13	14	8	1
Manufacture of cement, lime and plaster	26.5	24,059	73,223	1,039	67	11	10	7	5
Manufacture of articles of concrete, plaster and cement	26.6	86,409	462,924	25,705	70	13	11	6	1
Cutting, shaping and finishing of stone	26.7	17,064	202,920	35,731	88	9	2	1	0
Manufacture of other non-metallic mineral products (includes abrasive products)	26.8	20,736	97,776	3,516	69	13	10	8	0
Manufacture of basic metals	27	395,000 (estimate)	1,103,919	16,038	62	14	12	8	5

Sector	NACE code	Turnover (€m)	Number of Persons employed	Number of enterprises	% by size category (no. employees)				
					1-9	10-19	20-49	50-250	>250
Manufacture of fabricated metal products, except machinery and equipment	28	469,000 (estimate)	40,000 (estimate)	399,795	80	11	6	3	0
Manufacture of machinery and equipment n.e.c.	29	621,319	439,690	173,970	75	11	8	6	1
Manufacture of other transport equipment	35	165,422	904,237	12,687	4	2	5	10	80
Manufacture of jewellery and related articles	36.2	12,469	113,009	29,647	94	4	2	0	0
Construction	45	1,289,317	2,902,367	140,932	91	5	3	1	0
Total		3,233,684	6,825,178	893,462	80	10	6	3	2

Source: Eurostat classification of economic activities - NACE Rev.1.1

Note: Some figures for the EU-27 were derived by summing the known national figures; as other national figures were unavailable, these figures represent a lower estimate of the totals.

It can be seen from Table 2.2 that the sectors which constitute the greatest part of the economy are: construction, manufacture of machinery, manufacture of fabricated metal products, manufacture of basic metals and other transport equipment. It should also be noted that the majority of the firms in the affected sectors are SMEs, on average, with 90% of all enterprises operating with less than 19 employees.

2.2 PREVALENCE OF RESPIRABLE CRYSTALLINE SILICA EXPOSURE IN EU

The prevalence of exposure to RCS was estimated from 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 exposed workers in each industry was taken from each of these three CAREX estimates and the average proportion exposed across all three countries was found for each industry. The average proportion of exposed workers was applied to information on the number of employees in each industry obtained from the structural business statistics and the labour force survey available on the Eurostat database.³ The average proportion of exposed workers was multiplied by the number of workers employed in each industry in each country in 2006 to estimate the number of exposed workers in each industry and

³ Available at: <http://epp.ec.europa.eu/>

country. For Finland, Spain and Italy the proportion of exposed workers from their respective CAREX updates were used rather than the average proportion.

The prevalence of RCS exposure in the Finnish, Spanish and Italian CAREX updates for NACE codes 15, 16, 17, 18, 19, 22, 61, 62 and 63 were zero however the original 1993 CAREX estimates indicated that RCS exposure occurred in these industries in several EU member states (however, in many cases, not in Finland, Italy or Spain). We have no evidence to suggest that exposure has ceased in these industries therefore we estimated the 2006 exposure prevalence based on 1993 exposure proportions. We assumed that the proportion of exposed employees in each industry has remained constant since 1993. No clear trend in the change of proportion exposed from 1993 to 2008 was seen in other industries. The proportion of employees exposed in 1993 in each industry was averaged across all countries with exposed workers and then the average proportion was applied to the same countries in 2006 by multiplying by the number of persons employed in 2006 (data obtained from Eurostat) to estimate the number of exposed workers per industry. Countries which had zero exposed workers in an industry in 1993 were assigned zero exposed workers in 2006. France, Italy and Spain were all assigned zero exposed workers for industries identified to have zero prevalence of exposure to RCS in the 2006 CAREX updates.

The number of employees in some industry groups and countries was not available on the Eurostat database. Where possible, missing data have been substituted with 2005 data for the applicable industry and country. Where the 2005 data were also unavailable we have indicated that the data were unavailable for the industry and country.

The estimated exposure prevalence for the EU member states based on 2006 employment data is shown in Table 2.3. We have estimated that approximately 5 300 000 employees in the EU were potentially exposed to RCS.

The estimated number of male and female employees in each industry group in each EU member state is shown in Appendix 8.1. These data 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 Labour Force Survey available from the Eurostat database (single digit NACE Code data available only). Managers, salespeople and office clerks were excluded from these calculations as they were assumed to be unexposed.

Table 2.3 Number of workers exposed to respirable crystalline silica by country and NACE code

Country	NACE CODE												
	A	5	10	11	13	14	15	17	18	19	21	22	23
Austria	737	NK ^[1]	44	NK	NK	1745	56	27	20	24	104	54	NK
Belgium	282	842	NK	NK	NK	NK	71	57	19	9	84	73	16
Bulgaria	852	NK	5408	5	3894	2708	81	63	348	106	65	36	13
Cyprus	50	217	0	0	0	214	9	1	3	1	5	5	NK
Czech Republic	606	NK	11544	NK	17	2382	NK	85	84	56	118	94	8
Denmark	283	22	NK	NK	0	472	NK	11	6	NK	44	77	NK
Estonia	102	NK	NK	NK	0	314	13	17	27	8	11	14	3
Finland	505	0	94	0	144	529	0	0	0	0	299	0	0
France	3106	328	1240	21	208	10308	NK	141	168	152	463	400	74
Germany	2850	NK	16187	57	0	12872	608	187	136	99	847	771	56
Greece	1764	19	NK	NK	435	2239	63	34	93	29	44	60	11
Hungary	631	NK	101	10	165	1623	90	36	96	68	102	73	17
Ireland	388	NK	NK	NK	NK	1325	NK	6	4	1	20	33	NK
Italy	0	0	0	370	NK	NK	0	0	0	0	0	0	0
Latvia	405	4	714	0	0	290	0	0	0	0	10	0	0
Lithuania	625	NK	474	4	0	600	38	33	80	9	13	26	NK
Luxembourg	12	NK	0	0	0	121	NK	0	0	0	NK	NK	0
Malta	9	NK	NK	NK	NK	NK		NK	NK	NK	NK	NK	NK
Netherlands	877	NK	15	51	0	788	94	26	10	0	128	171	18
Poland	7798	NK	50074	23	NK	NK	331	154	382	184	261	206	40
Portugal	1998	65	0	0	634	5064	79	139	277	NK	71	77	NK
Romania	9657	104	7589	633	5247	4045	152	131	641	476	96	79	19
Slovakia	342	NK	NK	NK	NK	NK	NK	27	60	NK	45	24	NK
Slovenia	311	NK	NK	NK	NK	NK	14	18	26	28	31	21	0
Spain	5001	280	8921	0	207	9294	0	0	0	0	453	0	71
Sweden	326	NK	245	0	3172	969	NK	13	4	7	242	106	9
United Kingdom	1274	NK	2215	285	0	11013	326	143	94	55	434	698	65
TOTAL	40791	1879	104865	1458	14124	68916	2028	1349	2578	1311	3989	3097	418

Country	NACE CODE											
	24	25	26	27	28	29	31	33	35	36	40	41
Austria	24	177	11848	1963	1097	1092	25	189	63	174	256	26
Belgium	62	170	10798	2003	1040	586	16	97	53	94	148	59
Bulgaria	23	150	9824	1331	638	941	20	80	63	137	342	176
Cyprus	2	7	1130	22	58	14	0	2	1	10	NK	NK
Czech Republic	37	534	25735	3405	2556	2188	104	416	122	267	330	191
Denmark	27	131	6061	318	726	840	22	205	44	103	123	32
Estonia	3	33	1921	25	198	75	6	22	16	47	59	15
Finland	0	63	5186	995	378	350	0	78	0	73	209	0
France	244	1456	46335	5919	6571	4098	136	1574	831	565	1424	338
Germany	407	2386	80937	15254	12071	14156	467	3761	781	919	2089	399
Greece	16	74	8571	814	616	305	7	25	78	NK	NK	NK
Hungary	28	259	9598	1136	1141	920	62	231	45	123	293	204
Ireland	22	63	3659	145	201	155	7	299	21	NK	NK	0
Italy	0	2050	78101	10583	19673	14071	0	2369	0	1294	0	0
Latvia	4	29	2122	213	149	97	3	21	30	56	116	19
Lithuania	5	60	3997	55	282	146	6	46	40	114	172	58
Luxembourg	1	39	984	359	65	32	NK	26	NK	1	8	1
Malta	NK	NK	NK	NK	NK	NK	NK	NK	NK	NK	NK	NK
Netherlands	57	206	9801	1240	1507	1200	16	301	141	146	171	47
Poland	96	948	47255	4264	4251	2779	97	585	398	818	1397	455
Portugal	19	163	20206	572	1350	638	22	81	59	229	94	128
Romania	43	297	20216	3597	1573	1385	76	181	338	423	855	340
Slovakia	11	131	7028	1571	528	608	41	85	41	70	230	124
Slovenia	12	86	3224	539	521	364	14	79	15	59	69	38
Spain	372	552	76141	3335	3758	1840	245	364	969	340	455	880
Sweden	39	180	6800	2775	1302	1572	22	307	125	188	259	10
United Kingdom	190	1311	37721	4330	5089	3727	112	1277	824	667	984	250
TOTAL	1745	11556	535200	66763	67337	54179	1526	12701	5100	6918	10082	3789

NACE CODE												
Country	45	60	61	62	63	70	73	74	80	85	O	Grand Total
Austria	72659	820	8	68	199	235	22	521	108	10	1090	95486
Belgium	75620	647	30	40	178	166	26	733	186	14	900	95118
Bulgaria	53305	637	96	18	139	120	1	222	107	5	750	82703
Cyprus	9911	32	85	16	24	16	0	25	11	0	102	11973
Czech Republic	113120	1432	NK	NK	147	290	26	637	139	9	960	167639
Denmark	58369	530	261	41	116	287	27	450	105	14	955	70698
Estonia	14390	157	19	5	39	71	2	74	29	1	197	17910
Finland	47026	465	0	0	0	260	13	0	100	36	194	56996
France	475150	4967	299	524	955	1627	176	4300	878	83	6439	581498
Germany	431193	4569	585	402	1775	2179	394	5848	1028	114	11638	628021
Greece	89102	864	318	27	144	30	37	496	149	6	764	107236
Hungary	69033	1110	22	19	110	360	27	576	157	8	963	89436
Ireland	20855	206	NK	NK	70	122	10	253	64	6	585	28521
Italy	112908	4136	0	0	0	0	0	0	0	0	0	245555
Latvia	21047	325	13	8	58	185	5	78	43	1	295	26342
Lithuania	35917	443	31	6	55	157	3	100	66	3	379	44043
Luxembourg	10279	88	3	27	9	NK	NK	71	7	1	39	12173
Malta	NK	NK	NK	NK	NK	NK	NK	NK	6	0	34.3	49
Netherlands	138434	1332	NK	NK	314	437	142	2230	266	36	1730	161932
Poland	201471	3334	71	40	270	803	17	1203	560	24	3138	333727
Portugal	142043	714	42	70	136	325	5	836	154	9	857	177157
Romania	122965	1416	69	26	240	223	97	521	205	11	1426	185388
Slovakia	20748	420	13	6	38	85	19	125	82	4	461	32969
Slovenia	20641	218	5	5	31	22	11	96	37	2	232	26771
Spain	1277619	3745	0	0	0	2192	144	10397	843	0	12092	1420510
Sweden	78119	925	270	54	207	374	NK	633	240	21	1344	100861
United Kingdom	400900	3842	280	653	1318	2589	433	5795	1253	99	8657	498904
TOTAL	4112824	37376	2519	2056	6573	13155	1638	36219	6823	516	56220	5299619

^[1] NK = Not Known

NEPSI is the European Network for Silica. It is comprised of employers and employees in 15 industry sectors in which RCS exposure is common and who have signed the "Agreement on Workers' Health Protection Through the Good Handling and Use of Crystalline Silica and Products containing it". The 15 industry sectors covered by NEPSI are NACE 10, 11, 12, 13, 14 and 26 (all involving mining and manufacture of non-metallic mineral products). The companies within the signatory industries are required to provide quantitative data on the application of the agreement to NEPSI including the number of people potentially exposed to RCS at each worksite. In 2008 164206 potentially exposed employees were reported to NEPSI. The number of exposed workers that we have estimated for NACE 10, 11, 12, 13, 14 and 26 for 2006 based on CAREX and Eurostat data (718,145) is markedly higher than the number reported to NEPSI however this is not surprising as membership in NEPSI is voluntary therefore there are likely to be many workers who are exposed to RCS who do not work for employers that are within the NEPSI network. Also, CAREX may overestimate the number of exposed workers. The comparison between the number of exposed workers reported to NEPSI and the number of exposed workers estimated from CAREX and Eurostat data is shown in Table 2.4. In this report we have used the CAREX prevalence estimates.

Table 2.4 Number of employees potentially exposed to respirable crystalline silica reported to NEPSI in 2008 and the number of workers estimated to be exposed in NACE 10, 11, 12, 13, 14 and 26 from CAREX and Eurostat data

Country	Exposed Employees Reported to NEPSI, 2008	Estimated Number of Exposed workers using CAREX and Eurostat data, 2006	Ratio of NEPSI Estimate to CAREX estimate (%)
Austria	3605	13637	26
Belgium	6771	10798	63
Bulgaria	366	21839	2
Czech Republic	4727	39679	12
Denmark	762	6532	12
Estonia	463	2235	21
Finland	5374	5952	90
Portugal	22230	58113	38
Germany	43140	110053	39
Greece	2971	11245	26
Hungary	1329	11497	12
Ireland	1970	4985	40
Italy	10440	78472	13
Latvia	147	3126	5
Portugal	118	1105	11
Netherlands	5132	10655	48
Poland	3145	97352	3
Portugal	3831	25904	15
Romania	2321	37730	6
Slovakia	452	7028	6
Slovenia	1111	3224	34
Spain	16675	94564	18
Sweden	6611	11186	59
United Kingdom	20515	51234	40
Grand Total	164 206	718 145	23

Classification of Industries by Exposure Level

Industries in which RCS exposure occurs have been classified as high, medium or low 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. The exposure classification by industry is presented in Table 2.5.

Table 2.5 Classification of industries by exposure level

Industry	NACE (rev 1.1)	Classification ^[1]	Number of People Exposed in the EU 2006 ^[2]
Agriculture, hunting and related service activities	1	Low	40791
Forestry, logging and related service activities	2	Low	(NACE 1 and 2) 1879
Fishing, fish farming and related service activities	5	Low	
Mining of coal and lignite; extraction of peat	10	Low	104865
Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction, excluding surveying	11	Low	1458
Mining of metal ores	13	High	14124
Other mining and quarrying	14	High	68916
Manufacture of food products and beverages	15	Low	2028
Manufacture of textiles	17	Low	1349
Manufacture of wearing apparel; dressing and dyeing of fur	18	Low	2578
Tanning and dressing of leather, manufacture of luggage, handbags, saddlery, harness and footwear	19	Low	1311
Manufacture of pulp, paper and paper products	21	Low	3989
Publishing, printing and reproduction of recorded media	22	Low	3097
Manufacture of coke, refined petroleum products and nuclear fuel	23	High	418
Manufacture of chemicals and chemical products	24	High	1745
Manufacture of rubber and plastic products	25	Low	11556
Manufacture of other non-metallic mineral products	26	High	535200
Manufacture of basic metals	27	High	66763
Manufacture of fabricated metal products, except machinery and equipment	28	High	67337

Industry	NACE (rev 1.1)	Classification ^[1]	Number of People Exposed in the EU 2006 ^[2]
Manufacture of machinery and equipment n.e.c.	29	High	54179
Manufacture of electrical machinery and apparatus n.e.c.	31	Low	1526
Manufacture of medical, precision and optical instruments, watches and clocks	33	Low	12701
Manufacture of other transport equipment	35	High	5100
Manufacture of furniture; manufacturing n.e.c.	36	High	6198
Electricity, gas, steam and hot water supply	40	High	10082
Collection, purification and distribution of water	41	Low	3789
Construction	45	High	4112824
Land transport; transport via pipelines	60	Low	37376
Water transport	61	Low	2519
Air transport	62	Low	2056
Supporting and auxiliary transport activities; activities of travel agents	63	Low	6573
Real estate activities	70	Low	13155
Research and development	73	Low	1638
Other business activities	74	Low	36219
Education	80	Low	6823
Health and social work	85	Low	516
Sewage and refuse disposal, sanitation and similar activities	90	Low	56220

^[1] Relevant to 1975 exposure levels

^[2] Prevalence estimation methods are described at the beginning of this section

2.3 LEVEL OF EXPOSURE TO RESPIRABLE CRYSTALLINE SILICA

2.3.1 Estimation of exposure levels

In 2003 the UK HSE conducted a regulatory impact assessment (RIA) to examine the impact of proposals to reduce the UK OEL for RCS.⁴ As part of their assessment they estimated the number of workers in the UK exposed above 0.01 mg/m³, 0.05 mg/m³, 0.1 mg/m³ and 0.3 mg/m³. Their estimates were based on industry data, HSE data and a questionnaire on exposure prevalence and exposure levels that was sent out to UK companies in 2003. Overall they estimated that 1,696,500 workers in quarries, foundries, ceramics, heavy clay/bricks, construction, stonemasonry, slate splitting and general industry were exposed to RCS and that of those workers, 159612 – 164562 (9.4 – 9.7%) were exposed at levels above 0.01 mg/m³, 28762 – 156562 (1.7 – 9.2%) were exposed at levels above 0.05 mg/m³, 5052 – 7152 (0.3 – 0.4%) were exposed at

⁴ HSE (2003) A Regulatory Impact Assessment (RIA) on proposals to reduce the UK Occupational Exposure Limit for Respirable Crystalline Silica

levels above 0.1 mg/m³ and 1009 (0.1%) are exposed at levels above 0.3 mg/m³ (Table 2.6). The authors of the RIA believe that the exposure estimates for the construction industry are grossly underestimated. Ninety-four percent of the workers assessed in the RIA were in the construction industry therefore the overall estimates presented above are also likely to be underestimates.

HSE construction industry data from 1996 – 1997 showed that 30% of general construction workers were exposed above 0.3 mg/m³, 65% were exposed above 0.1 mg/m³ and 35% were exposed at levels below 0.1 mg/m³.⁵ Exposures typically decrease over time so these figures are probably not representative of current exposure levels, however, the data presented in Table 2.6 shows that no construction workers are exposed above 0.1 mg/m³. It is unlikely that exposures in the construction industry have decreased so much that no workers are exposed above 0.1 mg/m³ and exposure above 0.1 mg/m³ likely continues to occur in the construction industry. Since the construction industry includes a large proportion of all RCS exposed workers the estimate that 0.3 – 0.4% of all RCS exposed workers are exposed at levels above 0.1 mg/m³ is probably an underestimate.

Table 2.6 Estimates of respirable crystalline silica exposure in British industry and the approximate numbers exposed in 2003

Sector	Total workers in the industry sector 2003	Estimated exposed workers in the industry 2006 ^[1]	Workers exposed above 0.01 mg/m ³ (%)	Workers exposed above 0.05 mg/m ³ (%)	Workers exposed above 0.1 mg/m ³ (%)	Workers exposed above 0.3 mg/m ³ (%)
Foundry ^[2] (NACE 27)	25000	4330	4500 (18%)	2750 (11%)	1000 (4%)	500 (2%)
Ceramics ^[2] (NACE 26)	25000	37721 (All NACE 26)	4250 (17%)	1750 (7%)	250 (1%)	175 (0.7%)
Brick and heavy clay ^[2] (NACE 26)	6000	37721 (All NACE 26)	4980 (83%)	4320 (72%)	1320 (22%)	24 (0.4%)
Quarries ^[2] (NACE 14)	35000	11013 (All NACE 14)	2800 (8%)	1400 (4%)	1050 (3%)	210 (0.6%)
Slates ^[2] (NACE 14)	1000	11013 (All NACE 14)	1000 (100%)	1000 (100%)	1000 (100%)	0
Industrial minerals - silica flour production ^[3] (NACE 14)	40	11013 (All NACE 14)	32 (80%)	32 (80%)	32 (80%)	0

⁵ HSE (2003) A Regulatory Impact Assessment (RIA) on proposals to reduce the UK Occupational Exposure Limit for Respirable Crystalline Silica

Sector	Total workers in the industry sector 2003	Estimated exposed workers in the industry 2006 ^[1]	Workers exposed above 0.01 mg/m ³ (%)	Workers exposed above 0.05 mg/m ³ (%)	Workers exposed above 0.1 mg/m ³ (%)	Workers exposed above 0.3 mg/m ³ (%)
Use of silica containing industrial minerals ^[4] (VARIOUS)	2500	Not estimated	50 – 1000 (2 – 40%)	10 – 500 (0.4 – 20%)	0 – 100 (0 – 4%)	0
Construction ^[5] (NACE 45)	1600000	400900 (All NACE 45)	140000 (8.75%)	144000 (9%)	0	0
Stone masonry ^[4] (NACE 45)	2000	400900 (All NACE 45)	2000 (100%)	1000 (50%)	400 (20%)	100 (5%)
TOTAL ^[6]	1696540		159612 – 164562 (9.4 – 9.7%)	28762 – 156752 (1.7 – 9.2%)	5052 – 7152 (0.3 – 0.4%)	1009 (0.1%)

^[1] CAREX based prevalence estimates

^[2] Based on 2003 HSE industry questionnaire

^[3] Based on industry data

^[4] Based on current HSE estimate

^[5] Based on 2003 HSE industry questionnaire and likely to be a severe underestimate

^[6] Heavily biased by large uncertainties in the construction industry

Source: HSE (2003) A Regulatory Impact Assessment (RIA) on proposals to reduce the UK Occupational Exposure Limit for Respirable Crystalline Silica

The Industrial Minerals Association (IMA Europe) is an industry group representing the European industrial minerals industry. The work processes in this industry include quarrying, manufacturing for upgrading of the extracted raw materials, and final handling of materials. The industry consists mainly of SMEs and also includes some large multinational companies. IMA members operate over 810 sites throughout Europe. IMA-Europe maintains an exposure database of exposure data from more than 20 industrial mineral companies and 2000 workers throughout Europe. The companies have been collecting measurements on an ongoing basis using common methodology since 2000. The aim of the database is to compile data that is representative of all workers in the industrial mineral production industry. The Institute of Risk Assessment (IRAS) of the University of Utrecht is responsible for evaluation of the database. In late 2009, data collected from 2000 – 2007 was analyzed. The data consisted of 8140 respirable quartz measurements. Fifty-eight percent of the measurements exceeded 0.05 mg/m³, 41% exceeded 0.1 mg/m³ and 25% exceeded 0.2 mg/m³. A subset of the database consisted of measurements from workers for whom repeated measurements were taken. This data was used to estimate the percentage of workers who have typical exposures that exceed the assessed OELs by over 5%. It was estimated that 48% of workers have typical exposures exceeding 0.05 mg/m³, 35% have exposures typically exceeding 0.1mg/m³ and 21% have exposures typically exceeding 0.2 mg/m³ (Table 2.7).⁶

⁶ Communication with Industrial Minerals Association (IMA-Europe)

Table 2.7 Exceedence and overexposure to RCS within the industrial minerals industry

Exposure Limit	Percentage of measurements exceeding exposure limit by >5% (n = 8140)	Estimated probability of typical exposures exceeding exposure limit by >5% (n = 3602)
0.05 mg/m ³	58%	48%
0.1 mg/m ³	41%	35%
0.2 mg/m ³	25%	21%

Source: Industrial Minerals Association (IMA-Europe)

The available scientific literature was reviewed for RCS occupational exposure data. Insufficient data were available to estimate differences in exposure between EU member states. Based on the available data we have estimated geometric mean (GM) exposure levels and geometric standard deviations (GSD) for each high exposure industry that are representative of typical exposures throughout the EU. The estimated geometric mean and geometric standard deviations for high exposure industries are presented in Table 2.8. In addition to the exposure estimates taken from the published literature we have also used exposure estimates from the Finnish Job-Exposure Matrix (FINJEM) which is a database summarizing data from Finnish occupational exposure measurements supplemented with professional judgements (Kauppinen, 2001). The FINJEM exposure estimates are arithmetic means therefore where these estimates have been used adjustments have been made to make the estimates comparable to GMs.

Table 2.8 Estimated current RCS exposure levels for high exposure industries

NACE CODE		Exposure GM (mg/m ³)	Exposure GSD	Data Source
13	Mining of Metal Ores	0.027	2.7	Weeks and Rose (2006). This study was an analysis of 16000 samples from the US Mine Safety and Health Administration database.
14	Other mining and quarrying	0.027	2.7	See NACE 13
23	Manufacture of coke, refined petroleum products and nuclear fuel	0.025	3	FINJEM exposure database estimate for refinery workers and other chemical production. These estimates are not geometric means therefore the FINJEM exposure estimate was halved to approximate a geometric mean exposure (other FINJEM exposure estimates are approximately double known geometric means). GSD was estimated based on expert judgement.
24	Manufacture of chemical and chemical products	0.025	3	See NACE 23
26	Manufacture of other non-metallic mineral products	0.045	3	Finjem exposure database estimate for glass and ceramics workers halved to approximate a geometric mean. GSD was estimated based on expert judgement.
27	Manufacture of basic metals	0.028	2.8	Andersson <i>et al</i> (2009). The authors collected 435 respirable quartz measurements in the Swedish iron foundry industry to evaluate exposure across all job titles.
28	Manufacture of fabricated metal products except machinery and equipment	0.028	2.8	No industry specific data available. Processes are similar to those in NACE 27 therefore the exposure estimate for NACE 27 is assumed to be representative.
29	Manufacture of machinery and equipment	0.028	2.8	No industry specific data available. Processes are similar to those in NACE 27 therefore the exposure estimate for NACE 27 is assumed to be representative.
35	Manufacture of other transport equipment	0.028	2.8	No industry specific data available. Processes are similar to those in NACE 27 therefore the exposure estimate for NACE 27 is assumed to be representative.
36	Manufacture of furniture, manufacturing NEC	0.028	2.8	No industry specific data available. Processes are similar to those in NACE 27 therefore the exposure estimate for NACE 27 is assumed to be representative.
40	Electricity, gas, steam and hot water supply	0.09	5.7	No industry specific data available. Processes are similar to those in NACE 45 therefore the exposure estimate for NACE 45 is assumed to be representative.
45	Construction	0.09	5.7	Flanagan <i>et al</i> (2006) The authors compiled 1374 construction industry exposure measurements from 13 private research and regulatory groups. Measurements were taken across all construction trades. The exposure estimate presented was calculated from 796 measurements taken between 1999 and 2002.

Due to the limited availability of exposure data we were unable to determine whether there are systematic differences in exposures across the EU. We have assumed that the extrapolated 2010 exposures presented for high exposure groups in Table 2.8 are typical of exposures throughout the EU. The overall weighted GM and GSD was estimated across all high exposure industries across the EU using @Risk[®] (Palisade Corporation, New York). Exposures were simulated using the GM and GSD for each country. The number of values each country contributed was weighted according to the number of workers exposed in that country.

The estimated overall weighted geometric mean exposure across all countries and industries is 0.07 mg/m³ with a GSD of 5.2.

Based on these data and depending on the industrial sector, between about 25% and 65% of exposures exceed 0.05 mg/m³, between about 10% and 50% exceed 0.1 mg/m³ and between about 2% and 30% exceed 0.2 mg/m³. These data are discussed in more detail in relation to the intervention scenarios (Section 4).

2.3.2 Temporal change in exposure

In 2006 the Institute of Occupational Medicine (IOM) conducted a study of trends in inhalation exposure in the UK since the 1980's (Creely, 2006). This work included an assessment of trends in RCS exposure at quarries. A database of 2933 personal RCS measurement results taken by the IOM from 157 quarries were analysed to determine the change in RCS exposure over the study period. Analysis showed that there had been a 2.4% decrease per year in RCS exposure from 1984 to 1996, although this assessment may have been biased by issues related to the analytical detection limit. In the same study respirable dust was seen to decrease by 6% per annum.

Yassin *et al* (2005) analysed RCS personal exposure measurements from US Occupational Safety and Health Administration (OSHA) compliance inspections. The measurements came from all industries in the US which OSHA inspected for high RCS exposures. They found that between 1988 and 2003 RCS exposure concentrations decreased by 10% per year (Yassin *et al*, 2005).

Brown and Rushton (2005) examined 2429 personal and 583 static RCS samples collected at seven UK quarries in order to develop a job-exposure matrix for RCS exposure among UK industrial silica sand workers. An analysis of the yearly GM exposures presented by Brown and Rushton (2005) shows that exposure concentrations at these silica sand quarries decreased by about 7% per year between 1978 and 2000.

The available data suggests that RCS exposures have decreased from 2.4 – 10% per year over the past 20 – 30 years. The median annual decrease in exposure seen in the IOM study (Creely *et al*, 2006) for all agents and all industries was 7%. We believe that it is reasonable to assume a 7% decrease in silica exposure concentrations per year over the past 20 – 30 years.

2.4 HEALTH IMPACT FROM CURRENT EXPOSURES

2.4.1 Background data

The occupational cancers associated with exposure to respirable crystalline silica are shown in Table 2.9 along with a summary of the information used in the health impact assessment.

Table 2.9 Occupational cancers associated with exposure to respirable crystalline silica

Cancer site	Lung	
ICD-10 code	C33-C34	
IARC group for carcinogen	1	
Strength of evidence for cancer site ⁽¹⁾	Strong	
Latency assumption	10-50 yrs	
Source of forecast numbers - deaths	Eurostat, 2006	
Source of forecast numbers - registrations	GLOBOCAN, 2002 ⁷	
Exposure levels	Relative Risk (RR)	Source of RR
"High"	1.32 (1.24, 1.41)	Kurihara & Wada (2004)
"Low"	1.17 (1.12, 1.22)	Pelucchi <i>et al</i> (2006) - Miscellaneous exposure
"Background"	1 (0.85, 1.3)	Steenland <i>et al</i>

⁽¹⁾ Based on Siemiatycki *et al*, 2004

2.4.2 Exposed numbers and exposure levels

Industry sectors, their NACE codes, classifications to High/Medium/Low/Background exposure as applicable for the mid 1970's and numbers exposed in 2006 are given in Table 2.5 in the previous section on the exposure. The estimated average exposure level (GM) and measure of variability (GSD) for NACE industries used are in Table 2.8 for 2010.

We present data for a "baseline" scenario, which for all industries assumes a 7% annual decline in exposure levels and standard change in employed numbers up to the 2021-30 estimation interval and constant levels thereafter.

2.4.3 Forecast cancer numbers

Separate estimates for total numbers of deaths for lung 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 8.2.

⁷ IARC, GLOBOCAN database, available at: <http://www-dep.iarc.fr/globocan/database.htm>

2.4.4 Results

The cancer deaths and registrations attributed to occupational exposure to respirable crystalline silica 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 lung cancer for the total EU is in Table 2.10 below.

Table 2.10 Results for the baseline forecast scenario, total EU (27 countries), men plus women

Scenario	All scenarios		Baseline (trend) scenario (1) - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.			
EU Total	2010	2020	2030	2040	2050	2060
<i>Numbers ever exposed</i>	21,865,037	22,763,939	23,950,199	24,817,021	25,434,592	25,884,091
<i>Proportion of the population exposed</i>	6.052%	5.979%	6.160%	6.301%	6.489%	6.740%
Lung cancer						
<i>Attributable Fraction</i>	2.453%	2.350%	2.213%	1.923%	1.568%	1.265%
<i>Attributable deaths</i>	6,870	7,715	8,373	8,087	6,952	5,685
<i>Attributable registrations 'Avoided' cancers</i>	7,645	8,493	9,047	8,540	7,200	5,824
<i>YLLs</i>	103,403	112,744	116,896	107,070	88,004	70,091
<i>DALYs</i>	108,005	117,793	122,187	111,991	92,112	73,394

The attributable deaths from previous exposure to respirable crystalline silica exposures in the EU in 2010 were predicted to be considerable, with 6,870 attributable lung cancer deaths. The estimated deaths and cancer registrations increase until 2030 and then decrease over the following 30 years with 5,685 attributable lung cancer deaths predicted to occur in 2060. The corresponding estimated attributable fraction (AF) for lung cancer decreases from 2.45% in 2010 to 1.27% in 2060. DALYs are expected to decrease in the baseline scenario – from 108,005 years in 2010 to 73,394 years in 2060.

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 Years of Life Lost - 'YLL') for the baseline in which there are no further modifications to the Carcinogens Directive are shown in section 2.4 of this report. These data show that there are predicted to be a significant number of cancer registrations and YLLs from lung cancer resulting from predicted future exposure to respirable crystalline silica. There is predicted to be an increase in registrations and YLLs over time until 2040 despite an estimated 7% decline in exposure per year for all sectors. This reflects both the increasing prevalence of lung cancer in Europe and the delay between exposure and the onset of disease such that the benefits of improved control of exposure take a number of years to become apparent.

Method in brief

Using these health data, it is possible to monetise the costs under the baseline by estimating:

- 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, give a total value for COI. (COI is often the main market-based approach in relation to health impact⁸). COI includes the direct and indirect costs of cancer but not the intangible costs (see below).
- Willingness to Pay (WTP) to avoid cancer – WTP in this study 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 (such as disfigurement, functional limitations, pain and fear) and includes the costs associated with life years lost.

The cost variables used in this study are presented in Table 2.11 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 attaches to its health (as economic growth typically increases over a long period of time)⁹.

⁸ ECHA (2008) "Applying SEA as part of restriction proposals under REACH" Available at: http://echa.europa.eu/doc/reach/sea_workshop_proceedings_20081021.pdf

⁹ 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 2.11 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 in the European Commission's Impact Guidelines¹⁰. 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 2.4 are 'snap-shots' (i.e. an 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 2.12. Health-related costs are predicted to decline over time. This decline is predominately the result of applying a 4% discount rate.

Table 2.12 sets out the ranges of health costs for each representative decade. The ranges are based on the high and low cost scenarios (see Table 2.11). Total costs over the period 2010-2069 are estimated to be between €191bn and €493bn, with greater proportion of costs to males. The results are also illustrated in Figure 2.1.

Table 2.12 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	1,956 to 3,524	1,651 to 3,000	1299 to 2424	911 to 1,741	576 to 1,124	356 to 703	6,749 to 12,516
Male	46,122 to 117,522	41,864 to 107,474	36,517 to 94,722	28,188 to 74,210	19,374 to 52,012	12,765 to 34,693	184,831 to 480,633

¹⁰ European Commission impact Assessment Guidelines (Jan 2009) - http://ec.europa.eu/governance/impact/commission_guidelines/docs/iag_2009_en.pdf

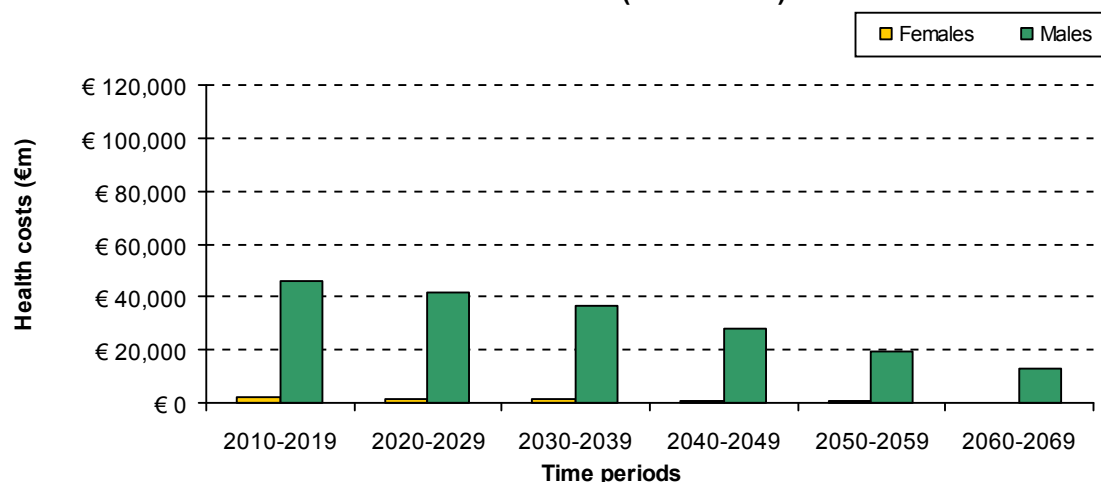
Total	48,078 to 121,046	43,515 to 110,474	37,817 to 97,146	29,099 to 75,951	19,950 to 5,3136	13,121 to 35,395	191,581 to 493,148
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Notes:

- 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

Health costs - baseline scenario (2010 - 2070) - Low scenario



Health costs - baseline scenario (2010 - 2070) - High scenario

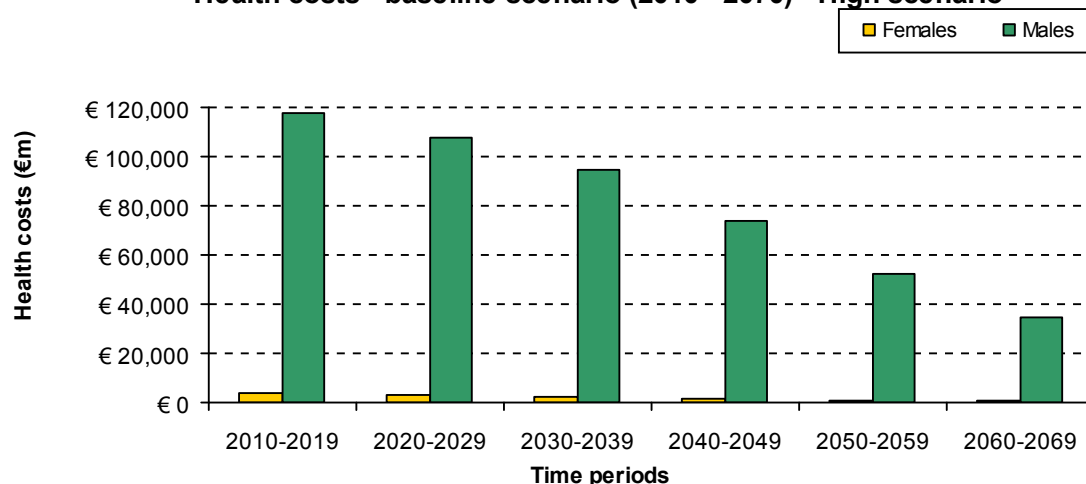


Figure 2.1 Health costs - baseline scenario – 2010 to 2070 (Present Value – 2010 €m prices)

These 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, Spain and the UK are predicted to have relatively high health costs. The industrial sector

estimated to be most affected under the baseline is the construction industry followed by the manufacture of other non-metallic mineral products. This is shown in Figure 2.3 for the construction and manufacture of other non-metallic mineral products and in Figure 2.5 for all other industries.

Detailed tables are included in the Appendix 8.3.

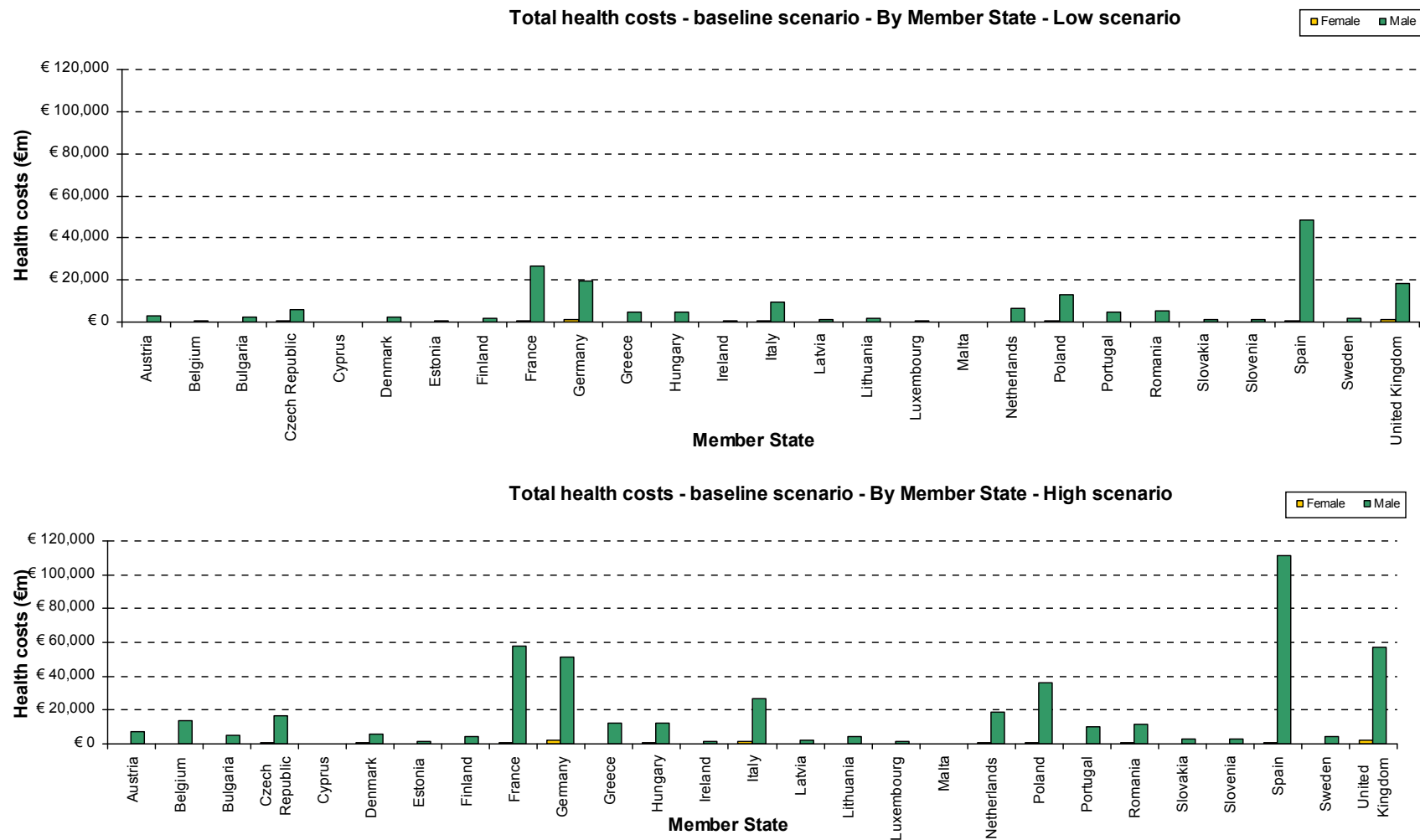


Figure 2.2 Total health costs- baseline scenario – By Member State (Present Value – 2010 €m prices)

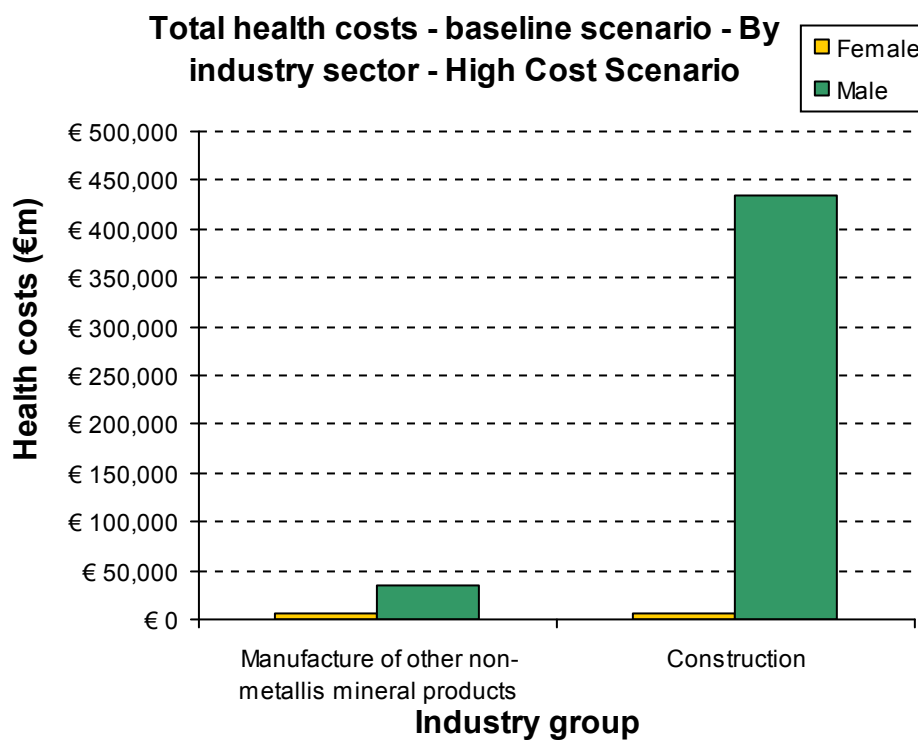
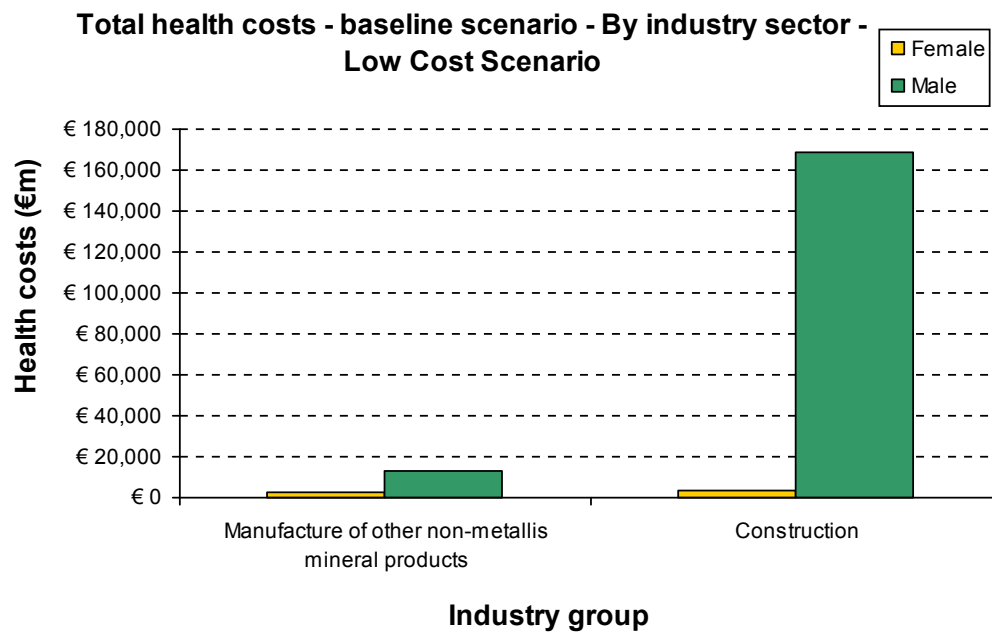


Figure 2.3 Total health costs - baseline scenario - by industry group – Construction and Manufacture of other non-metallic mineral products (Present Value – 2010 €m prices)

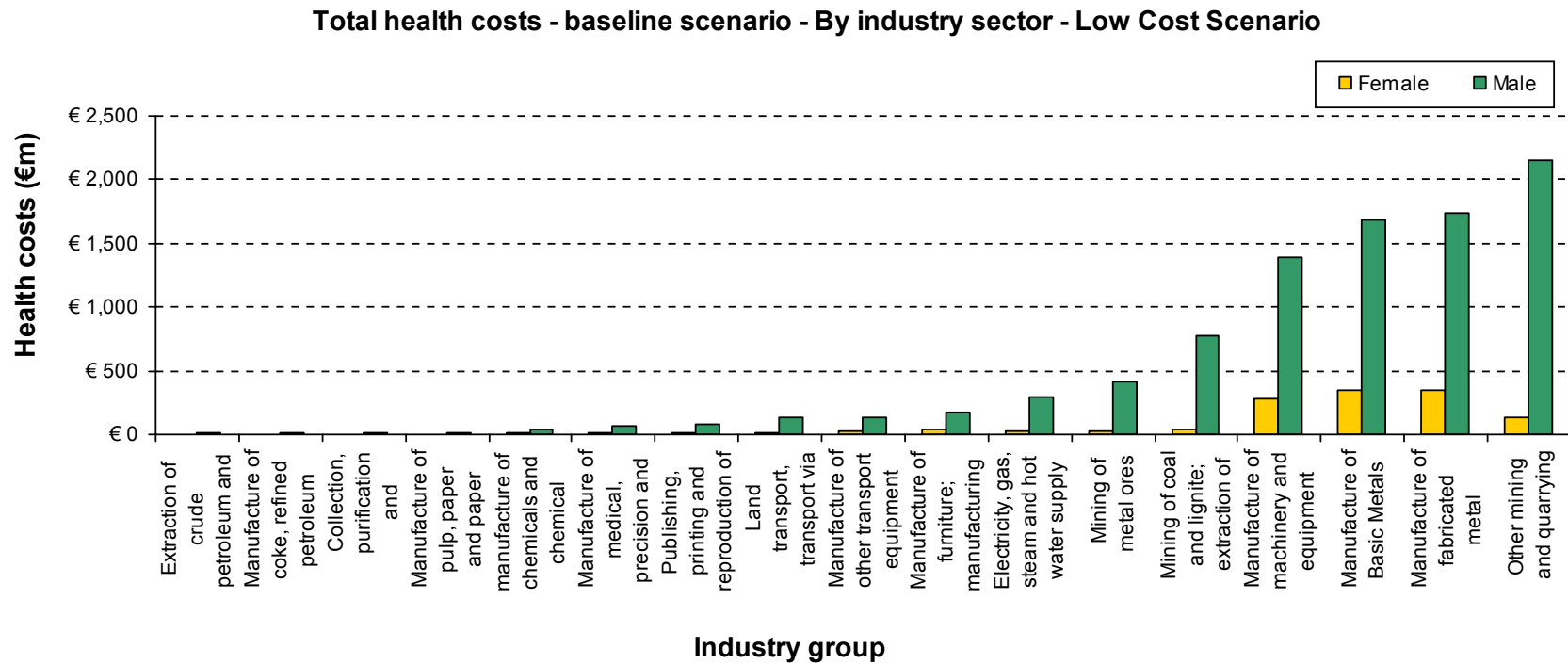


Figure 2.4a Total health costs - baseline scenario - by industry group (Present Value – 2010 €m prices)¹¹ - low cost scenario

¹¹ Charts exclude industries for which insignificant costs are estimated and for purposes of presentation the two industries with highest health costs are shown separately in Figure 2.3a

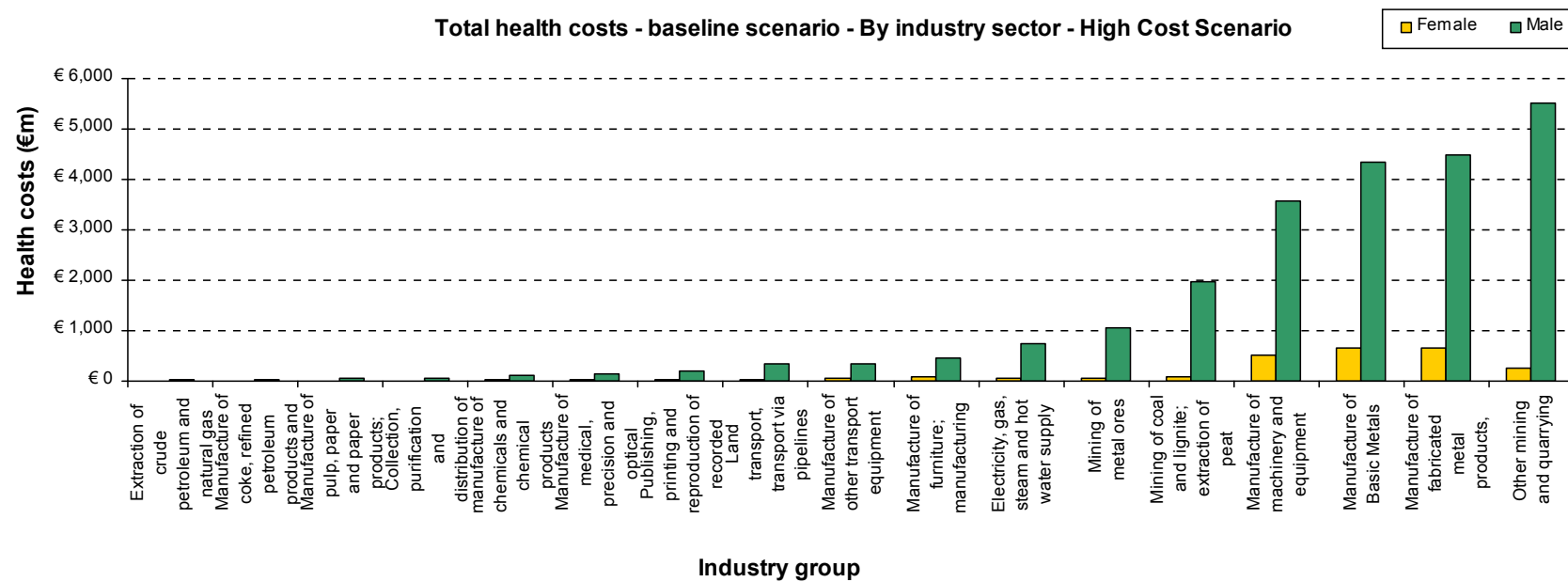


Figure 2.5b Total health costs - baseline scenario - by industry group (Present Value – 2010 €m prices)¹² - low cost scenario

¹² Charts exclude industries for which insignificant costs are estimated and for purposes of presentation the two industries with highest health costs are shown separately in Figure 2.3a

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 2.6, the effects of different discount rates on the overall results are shown, indicating that the impacts of discounting become more pronounced in the future.

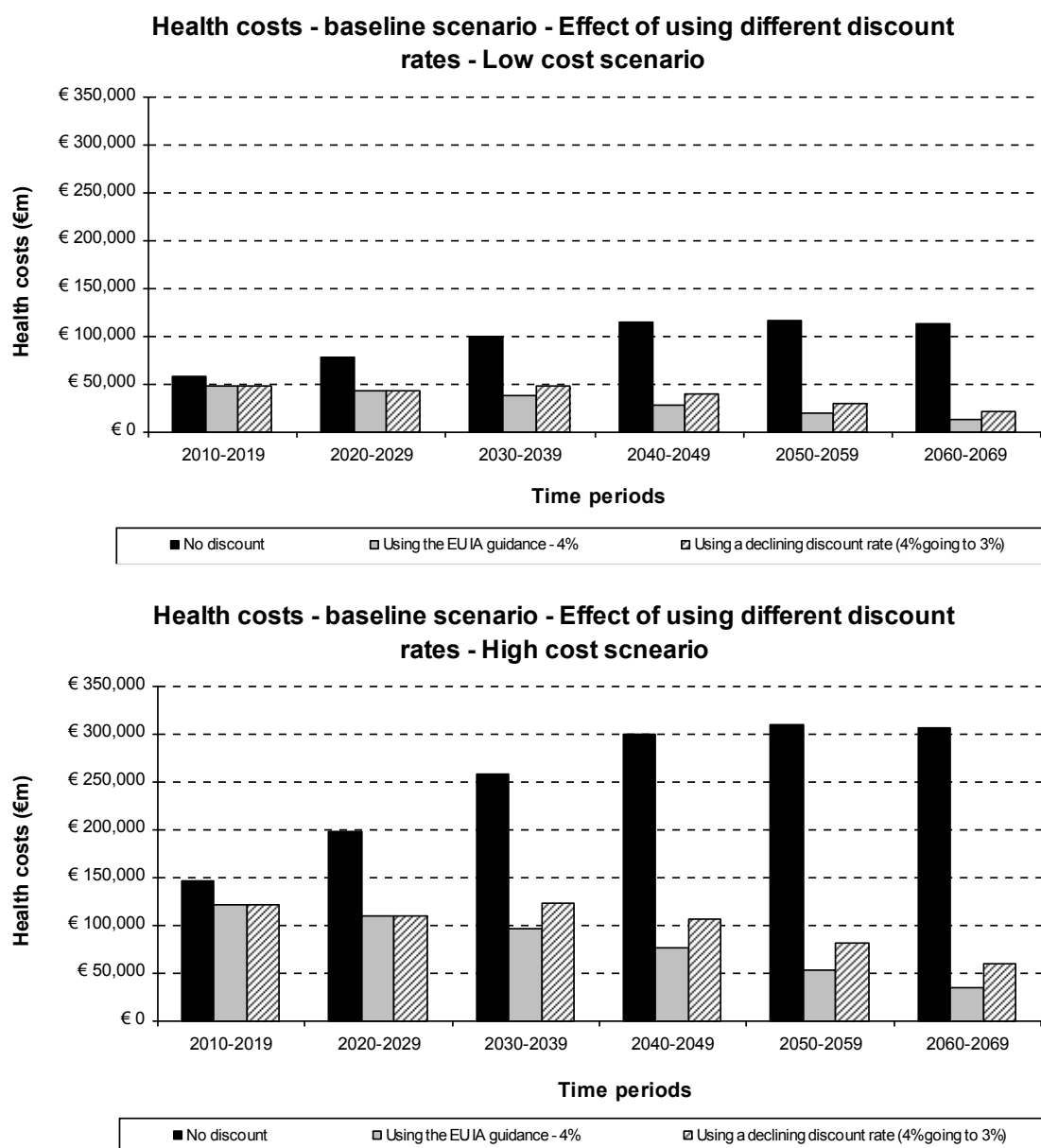


Figure 2.6 Impacts of discounting

3 POLICY OPTIONS

3.1 DESCRIPTION OF MEASURES

The proposed measure is to introduce an OEL and the options considered were OELs of 0.05, 0.1 and 0.2 mg/m³.

3.2 LEVEL OF PROTECTION ACHIEVED (OELS)

The estimated GM exposures in the high exposure industries were all below two of the three proposed EU OELs of 0.1 and 0.2 mg/m³. The estimated GM for NACE 40 and 45 was 0.09 mg/m³, which is above the other proposed EU OEL of 0.05 mg/m³. The estimated GM exposure for NACE 26 was 0.045 mg/m³ with a GSD of 2.8 suggesting that increased controls would be required in this industry is to meet an OEL of 0.05.

The percentage of workers within each high exposure industry who are estimated to be currently exposed above the three OELs considered was estimated based on exposure distributions simulated using the estimated GM and GSD for each industry (Table 3.1). These estimates indicate that exposure reductions would be required in all industries to meet *all* three proposed OELs.

Table 3.1 Estimated percentage of workers with exposure exceeding the proposed OELs in high exposure industries

OEL (mg/m ³)	NACE CODE				
	13 and 14 (%)	23 and 24 (%)	26 (%)	27, 28, 29, 35 & 36 (%)	40 & 45 (%)
0.05	26.8	26.4	46.2	28.7	63.2
0.1	9.4	10.4	23.4	10.8	47.6
0.2	2.2	2.9	8.7	2.8	32.3

NEPSI has created a Good Practice Guide for working with silica that provides a step-by-step risk assessment procedure to help employers identify and effectively control exposures to maintain silica exposure levels below occupational exposure limits in general.¹³ The good practice guide recommends that employers tailor control strategies to the needs of the individual exposure scenario. Example control strategies that are recommended include the following:

- Substitution of dusty processes with processes that generate less dust (for example a wet process instead of a dry process or an automated process instead of a manual process);
- Use of engineering controls including dust suppression, collection and containment, isolation techniques;
- Good housekeeping practices including wet cleaning or vaccuming (no sweeping or dusting);
- Job rotation to reduce total exposure duration;
- Respiratory protective equipment (RPE); and
- Worker training including safe work procedures and exposure awareness.

¹³ Available at: <http://www.nepsi.eu/agreement-good-practice-guide/good-practice-guide.aspx>

Generally a combination of the above control strategies are used to control exposure to RCS.

In their 2003 Regulatory Impact Assessment (RIA)¹⁴, the UK HSE listed the additional controls required for several industries to meet four potential OELs for RCS; 0.3, 0.1, 0.05 and 0.01 mg/m³. The control requirements were identified by assessment of industry and HSE exposure data, literature review, a questionnaire to industry in which companies were asked what additional controls they would require to meet the potential OELs, and expert judgement. The findings of the RIA were that an OEL of 0.1 or 0.05 mg/m³ would be achievable by all of the industries examined through the use of local exhaust ventilation (LEV), dust suppression, annual monitoring and RPE. An OEL of 0.01mg/m³ was deemed to be unachievable in most industries without automation of processes through the use of robotics or complete reliance on air-fed respirators. The RIA suggested that, if an OEL of 0.01 mg/m³ was implemented then entire industries may be required to close completely. The control requirements for each industry that are reported in the RIA are presented in Table 3.2.

¹⁴ HSE (2003) A Regulatory Impact Assessment (RIA) on proposals to reduce the UK Occupational Exposure Limit for Respirable Crystalline Silica

Table 3.2 Additional controls required for UK companies to comply with proposed RCS OELs of 0.3, 0.1, 0.05 and 0.01 mg/m³

Industry	OEL (mg/m ³)			
	0.3	0.1	0.05	0.01
Foundries (NACE 27, 28, 29, 35)	No additional controls needed	Additional annual monitoring and LEV improvement.	Additional annual monitoring, increased use of LEV and RPE.	Automation of process through the use of robotics, complete reliance on air-fed respirators or complete closure of the industry.
Ceramics (NACE 26)	Additional annual monitoring and improved engineering controls for 3% of small potteries.	Additional annual monitoring and additional use of RPE.	Additional annual monitoring increased use of LEV.	Large engineering control improvements including implementation of refuges stations, dust suppression and extraction or continual use of RPE.
Brick manufacture and heavy clay (NACE 26)	Additional annual monitoring and LEV for 0.4% of worksites.	Additional annual monitoring and LEV for 22% of worksites.	Additional annual monitoring and increased use of LEV for 72% of worksites and increased use of RPE.	Automation of process through the use of robotics, complete reliance on air-fed respirators or closure of the industry.
Quarries (NACE 14)	Additional annual monitoring for 0.6% of sites.	Use of air conditioned, ventilated cabs for drilling rigs, extra refuges for 11% of worksites.	Extra air conditioned ventilated cab for large drilling rig and extra refuge for 58% of worksites.	Automation of process through the use of robotics, complete reliance on air-fed respirators or closure of the industry.
Slate Quarries (NACE 14)	No additional controls needed	Additional annual monitoring and increased LEV for all sites.	Additional annual monitoring, increased use of LEV and use of powered respirators for some employees at all sites.	Automation of process through the use of robotics, complete reliance on air-fed respirators or closure of the industry.
Silica sand quarrying (NACE 14)	No additional controls needed	Additional annual monitoring for 11% of sites.	Additional annual monitoring for 58% of sites.	Automation of process through the use of robotics, complete reliance on air-fed respirators or closure of the industry.
Silica flour production (NACE 14)	No additional controls needed	Automation of bagging, improved dust capture and dust suppression in milling and transport.	Automation of bagging, improved dust capture and dust suppression in milling and transport.	Automation of process through the use of robotics, complete reliance on air-fed respirators or closure of the industry.

Industry	OEL (mg/m ³)			
	0.3	0.1	0.05	0.01
Use of silica-containing industrial materials (Various NACE groups)	No additional controls needed	Use of bag-balers for the production of scouring powders, increased monitoring in the glass polishing industry.	Additional annual monitoring and use of bag-balers and RPE for the production of scouring powders. Additional annual monitoring and increased LEV for mixing of silica flour during production of composites. Additional annual monitoring and increased LEV in jewellery-casting. Additional annual monitoring and use of extracted changing rooms in the glass polishing industry.	Automation of process through the use of robotics, complete reliance on air-fed respirators or closure of the industry.
Construction (NACE 45)	No additional controls needed	Water suppression during cutting of concrete blocks and kerbstones, increased use of power assisted respirators.	Additional annual monitoring, water suppression during cutting of concrete blocks and kerbstones, increased use of power assisted respirators, staff training in the use of controls (including water suppression).	Complete reliance on air-fed respirators or complete closure of the industry.
Stonemasonry (NACE 45)	Downdraught extraction for hand tools, increased use of wet cutters and polishers.	Additional annual monitoring, downdraught extraction for hand tools, increased use of wet cutters and polishers.	Additional annual monitoring, installation of extraction booths, down-draught extraction for hand tools, increased use of wet cutters and polishers	Automation of process through the use of robotics, complete reliance on air-fed respirators or closure of the industry.

Source: HSE (2003) A Regulatory Impact Assessment (RIA) on proposals to reduce the UK Occupational Exposure Limit for Respirable Crystalline Silica

3.2.1 Classification of sectors for cost estimates

In order to produce estimates of compliance costs (see section 4.2.1) for enterprises for sectors with high risks of exposure to RCS, the following information sources were used:

- Estimates of the number of enterprises, employees, operating surplus, expenditure on goods and services and research and development expenditure were taken from Eurostat¹⁵; where available, data differentiated by size of enterprise was used.
- Estimates of the number of workers exposed in each industry presented in Table 3.1 were used to estimate the number of enterprises and workers which would require investment in protective equipment for each sector.
- Estimates of the costs of protective equipment measures were taken from the Health and Safety Executive (HSE) Regulatory Impact Assessment (RIA) (2003)¹⁶. All costs were converted to Euros (2010) using the average £/€ exchange rate for 2003¹⁷ and the Euro area inflation index for the period 2003 – 2010¹⁸.

Where other sources of compliance cost data were available, these were used as a comparison for the estimates of compliance costs produced using HSE (2003) data.

Because the estimates of compliance costs from HSE (2003) were differentiated by sub-sector, compliance cost estimates have been produced separately for each sub-sector.

¹⁵ Eurostat Statistics database, available at:

http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

¹⁶ Health and Safety Executive, (2003), 'A Regulatory Impact Assessment (RIA) on proposals to reduce the UK Occupational Exposure Limit for Respirable Crystalline Silica (RCS)'.

¹⁷ Figure taken from Eurostat. Available from:

http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

¹⁸ Figure taken from Eurostat. Available from:

<http://epp.eurostat.ec.europa.eu/portal/page/portal/hicp/data/database>

Table 3.3 below lists the sub-sectors for which compliance costs were estimated, the relevant NACE code and how the sub-sectors' costs were categorised in HSE (2003).

Table 3.3 Sectors for which compliance costs have been assessed

NACE Code (rev. 1.1)	NACE Description	HSE (2003) Categorisation (where costs estimated are from)
13	Mining of metal ores	Quarry
14.1	Quarrying of Stone	Quarry
14.3	Mining of chemical and fertiliser minerals	Quarry
14.5	Production of salt	Quarry
14.5	Other mining and quarrying n.e.c.	Quarry
45	Construction	Construction
27	Manufacture of basic metals	Foundry
28	Manufacture of fabricated metal products, except machinery and equipment	Foundry
29	Manufacture of machinery and equipment n.e.c.	Foundry
35	Manufacture of other transport equipment	Foundry
26.2	Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products	Ceramics
26.3	Manufacture of ceramic tiles and flags	Ceramics
26.4	Manufacture of bricks, tiles and construction products, in baked clay	Brick Manufacture
14.2	Quarrying of sand and clay	Silica Sand Production & Silica Flour Production
26.8	Manufacture of other non-metallic mineral products (includes abrasive products)	Scouring Powders
26.1	Manufacture of glass and glass products	Glass Polishing
26.5	Manufacture of cement, lime and plaster	Composites
26.6	Manufacture of articles of concrete, plaster and cement	Composites
36.2	Manufacture of jewellery and related articles	Jewellery casting
26.7	Cutting, shaping and finishing of stone	Stonemasonry

Note 1: Compliance costs for slate quarrying were not assessed separately, because Eurostat data was not available at that level of disaggregation and slate quarrying (14.13) is already included within quarrying of stone (14.1).

3.2.2 Estimating the number of workers exposed

Table 3.4 sets out the estimated the number of workers currently exposed above the three proposed OEL levels. It uses information from Table 2.3 on the number of workers exposed to RCS and the percentages of those workers exposed above the OEL from Table 3.1. The largest exposures above the OEL are likely to be workers in the construction sector.

Table 3.4 Estimates of the number of workers exposed

Sector	NACE code (rev 1.1)	Number of workers exposed	Percentage of workers exposed above OEL (mg/m ³)			Number of workers exposed above OEL (mg/m ³)		
			0.2	0.1	0.05	0.2	0.1	0.05
Quarry	13, 14.1, 14.3, 14.5	69,257	2.2%	9.4%	26.8 %	1,524	6,510	18,561
Construction	45	4,112,824	32.3%	47.6%	63.2 %	1,328,442	1,957,704	2,599,305
Foundry	27,28,29,35	193,379	2.8%	10.8%	28.7 %	5,415	20,885	55,500
Ceramics	26.2,26.3	133,800	8.7%	23.4%	46.2 %	11,641	31,309	61,816
Brick	26.4	66,900	8.7%	23.4%	46.2 %	5,820	15,655	30,908
Manufacture of Silica Sand Production & Silica Flour Production	14.2	13,783	2.2%	9.4%	26.8 %	303	1,296	3,694
Scouring Powders	26.8	66,900	8.7%	23.4%	46.2 %	5,820	15,655	30,908
Glass Polishing	26.1	66,900	8.7%	23.4%	46.2 %	5,820	15,655	30,908
Composites	26.5,26.6	133,800	8.7%	23.4%	46.2 %	11,641	31,309	61,816
Jewellery casting	36.2	6,198	2.8%	10.8%	28.7 %	174	669	1,779
Stone-masonry	26.7	66,900	8.7%	23.4%	46.2 %	5,820	15,655	30,908
Manufacture of coke, refined petroleum products and nuclear fuel	23	418	2.9%	10.4%	26.4 %	12	43	110
Manufacture of chemicals and chemical products	24	1,745	2.9%	10.4%	26.4 %	51	181	461
Electricity, gas, steam and hot water supply	40	10,082	32.3%	47.6%	63.2 %	3,256	4,799	6,372

3.2.3 Number of enterprises affected by enterprise size

Using the estimates of the number of workers exposed (in Table 3.4) and Eurostat data on the distribution of firms by size (based on the average number of employees per

enterprise in each size band) it was possible to broadly estimate the number of enterprises requiring further action to comply with each proposed OEL.

It is recognised there are limitations to this approach, as it assumes that affected workers are distributed across the NACE code sector in the same way as the average distribution for the NACE code as a whole. For example, if the sector is predominately made up of enterprises employing less than nine people, then most workers affected will be employed in enterprises employing less than nine people and the predicted number of affected enterprises will be higher than if the sector was predominately made up of enterprises employing over 250 workers; whereby the predicted number of enterprises affected will be smaller. In the absence of better data, this is seen as a reasonable approach to broadly estimating the number of enterprises affected.

The following tables (Table 3.5, Table 3.6 and Table 3.7) set out the estimated number of firms affected by size for each possible OEL, based on the approach set out above.

Table 3.5 Estimated number of enterprises affected by an OEL of 0.2mg/m³

Sector	Number of enterprises affected with 1 & 9 employees	Number of enterprises affected with 10 & 19 employees	Number of enterprises affected with 20 & 49 employees	Number of enterprises affected with 50 & 250 employees	Number of enterprises affected with >250 employees
Quarry	230	14	3	0	0
Construction	242,638	4,655	951	73	2
Foundry	784	42	13	2	0
Ceramics	1,614	102	32	6	0
Brick	807	51	16	3	0
Manufacture Silica Sand	46	3	1	0	0
Production & Silica Flour					
Scouring	807	51	16	3	0
Powders					
Glass	807	51	16	3	0
Polishing					
Composites	1,614	102	32	6	0
Jewellery casting	33	0	0	0	0
Stone-masonry	807	51	16	3	0
Manufacture of coke, refined petroleum products and nuclear fuel	2	0	0	0	0
Manufacture of chemicals and chemical products	6	0	0	0	0
Electricity, gas, steam and hot water supply	488	22	9	1	0

Table 3.6 Estimated number of enterprises affected by an OEL of 0.1 mg/m³

Sector	Number of enterprises affected with 1 & 9 employees	Number of enterprises affected with 10 & 19 employees	Number of enterprises affected with 20 & 49 employees	Number of enterprises affected with 50 & 250 employees	Number of enterprises affected with >250 employees
Quarry	984	58	15	1	0
Construction	357,572	6,860	1,402	108	3
Foundry	3,025	161	50	7	1
Ceramics	4,342	274	87	16	0
Brick Manufacture	2,171	137	44	8	0
Silica Sand	196	12	3	0	0
Production & Silica Flour Production					
Scouring Powders	2,171	137	44	8	0
Glass Polishing	2,171	137	44	8	0
Composites	4,342	274	87	16	0
Jewellery casting	125	2	0	0	0
Stonemasonry	2,171	137	44	8	0
Manufacture of coke, refined petroleum products and nuclear fuel	7	0	0	0	0
Manufacture of chemicals and chemical products	21	2	1	0	0
Electricity, gas, steam and hot water supply	720	32	14	1	0

Table 3.7 Estimated number of enterprises affected by an OEL of 0.05mg/m³

Sector	Number of enterprises affected with 1 & 9 employees	Number of enterprises affected with 10 & 19 employees	Number of enterprises affected with 20 & 49 employees	Number of enterprises affected with 50 & 250 employees	Number of enterprises affected with >250 employees
Quarry	2,806	166	42	4	0
Construction	474,760	9,108	1,861	144	4
Foundry	8,037	429	134	20	2
Ceramics	8,573	542	172	32	0
Brick Manufacture	4,286	271	86	16	0
Silica Sand	559	33	8	1	0
Production & Silica Flour Production					
Scouring Powders	4,286	271	86	16	0
Glass Polishing	4,286	271	86	16	0
Composites	8,573	542	172	32	0
Jewellery casting	333	5	1	0	0
Stonemasonry	4,286	271	86	16	0
Manufacture of coke, refined petroleum products and nuclear fuel	17	1	0	0	0
Manufacture of chemicals and chemical products	53	4	2	0	0
Electricity, gas, steam and hot water supply	956	42	18	2	0

3.2.4 Total number of enterprises affected

Table 3.8 sets out estimates of total number of enterprises affected for the introduction of each possible OEL based on the tables above.

Table 3.8 Total number of workers affected

Sector	Total number of enterprises affected		
	0.2 mg/m ³	0.1 mg/m ³	0.05 mg/m ³
Quarry	248	1,059	3,018
Construction	248,320	365,946	485,877
Foundry	841	3,245	8,623
Ceramics	1,755	4,720	9,318
Brick Manufacture	877	2,360	4,659
Silica Sand Production & Silica Flour Production	49	211	601
Scouring Powders	877	2,360	4,659
Glass Polishing	877	2,360	4,659
Composites	1,755	4,720	9,318
Jewelry casting	33	128	339
Stonemasonry	877	2,360	4,659
Manufacture of coke, refined petroleum products and nuclear fuel	2	7	18
Manufacture of chemicals and chemical products	7	23	59
Electricity, gas, steam and hot water supply	520	767	1,018

4 ANALYSIS OF IMPACTS

4.1 HEALTH IMPACTS FROM CHANGES TO THE EU DIRECTIVE

4.1.1 Health information

The impacts of setting OELs of 0.05, 0.1 and 0.2 mg/m³ for respirable crystalline silica were assessed. Lung cancer numbers were estimated based on full compliance¹⁹ to these OELs. The baseline for all industries assumes a 7% annual decline in exposure levels and standard change in employed numbers up to the 2021-30 estimation interval and constant levels thereafter.

We present data for three “intervention” scenarios as described in Table 4.1 below, compared to the baseline trend scenario described in section 2.4.1.

¹⁹ Full compliance is assumed in the intervention scenarios; however, due to modelling restrictions full compliance is modelled as 99% compliance.

Table 4.1 Baseline and intervention scenarios for respirable crystalline silica

Intervention scenarios⁽¹⁾		
Baseline scenario (1)	(trend)	Linear employment and exposure level trends assumed to 2021-30, constant thereafter.
Intervention scenario (2)		Full compliance for OEL = 0.05 mg/m ³
Intervention scenario (3)		Full compliance for OEL = 0.1 mg/m ³
Intervention scenario (4)		Full compliance for OEL = 0.2 mg/m ³

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

Results for the baseline scenario (1) and the intervention scenarios (2) to (4) compared to the baseline scenario are in Figure 4.1 (attributable registrations), Figure 4.2 (for attributable fractions) and Figure 4.3 (for DALYs) for men plus women for the total EU (27 countries) for lung cancer. A summary of the results for lung cancer for the total EU is in Table 4.2 below. Due to cancer latency, no effect is seen from interventions in 2010 until 2030.

Introducing full compliance with the current OEL in 2010 will avoid cancers occurring but only from 2040 onwards (Figure 4.1 and Figure 4.2).

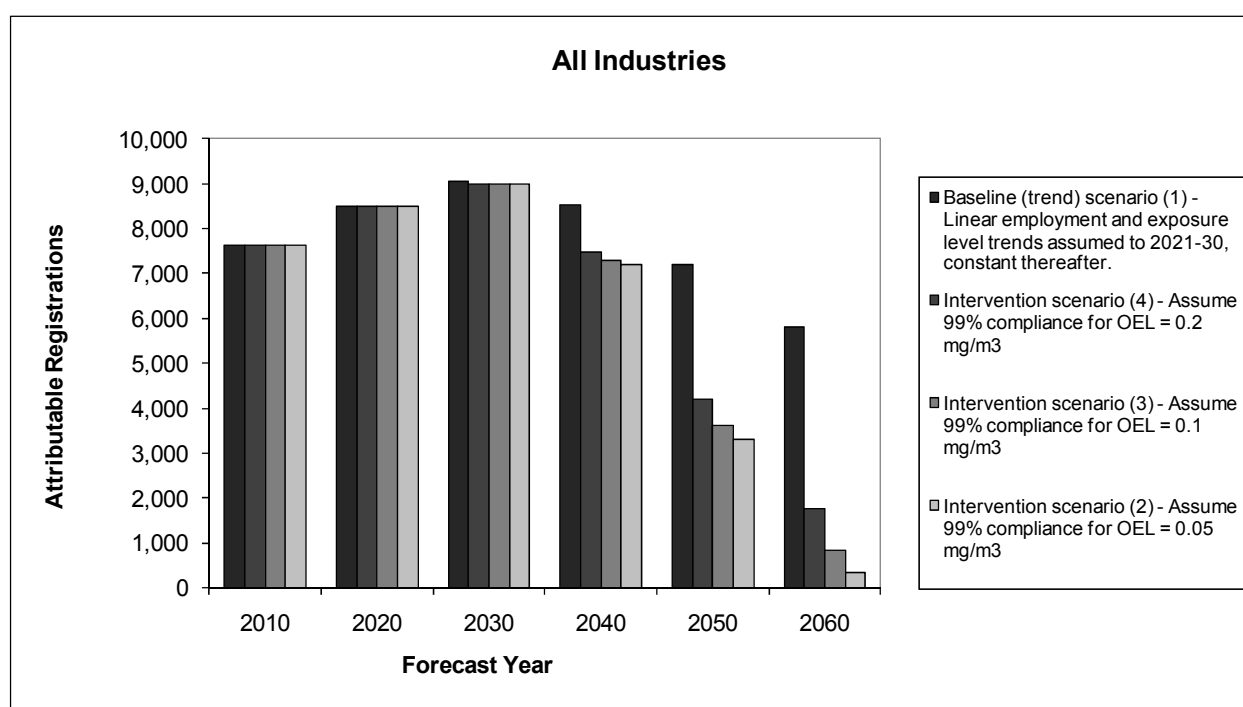


Figure 4.1 Results for baseline (1) and the intervention scenarios (2) to (4) compared to the baseline scenario – Occupational Attributable cancer registrations, Lung cancer, men plus women

Figure 4.1 shows a greater reduction in the number of registrations for lung cancer attributable to respirable crystalline silica exposure in the intervention scenarios than observed for the baseline scenario over the next 50 years.

Figure 4.2 shows that the attributable fraction decreases over the period up to 2060. The decrease is more substantial for all three of the intervention scenarios resulting in less than 0.05% of all lung cancer attributed to respirable crystalline silica exposure by 2060, while the baseline scenario only decreases to just under 1.5% by 2060.

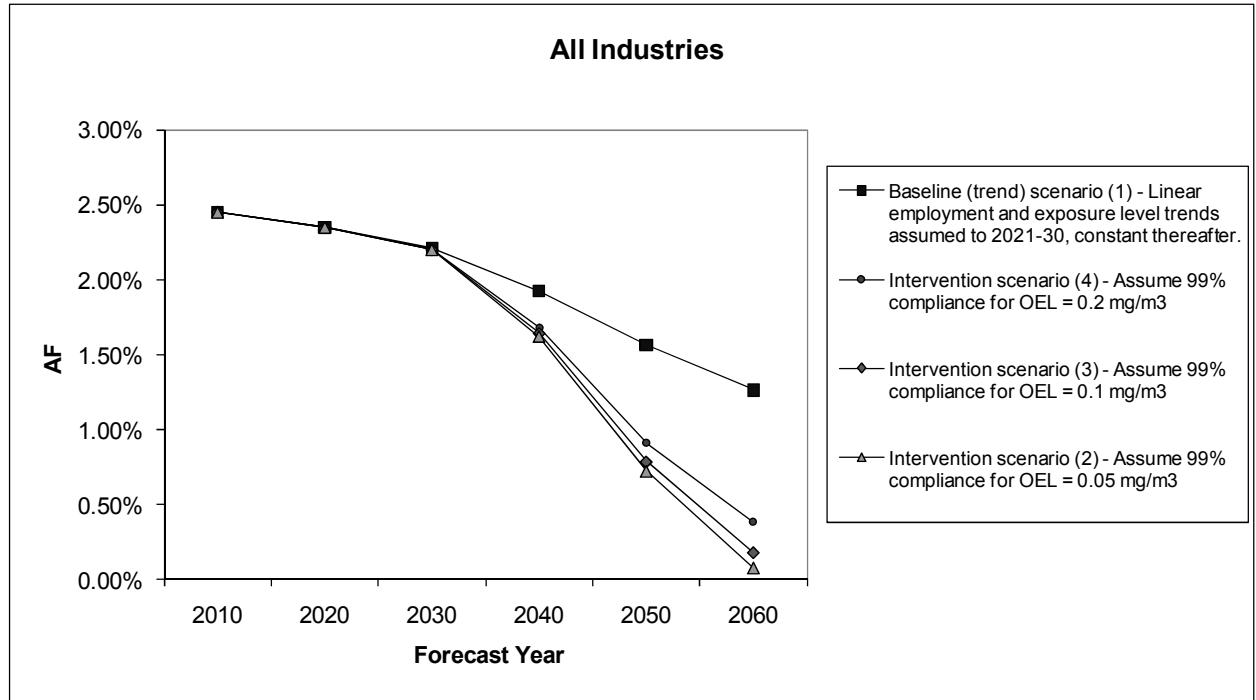


Figure 4.2 Occupation Attributable Fractions, Lung cancer

The estimated DALYs increase between 2010 and 2030 for all of the scenarios. After 2030, the DALYs are expected to decrease for the three intervention scenario from approximately just over 100,000 years in 2010 to under 20,000 years for the three scenarios. The DALYs for the baseline scenario follow a similar trend and decrease from just over 100,000 years in 2010 to approximately 70,000 years in 2060 (Figure 4.3).

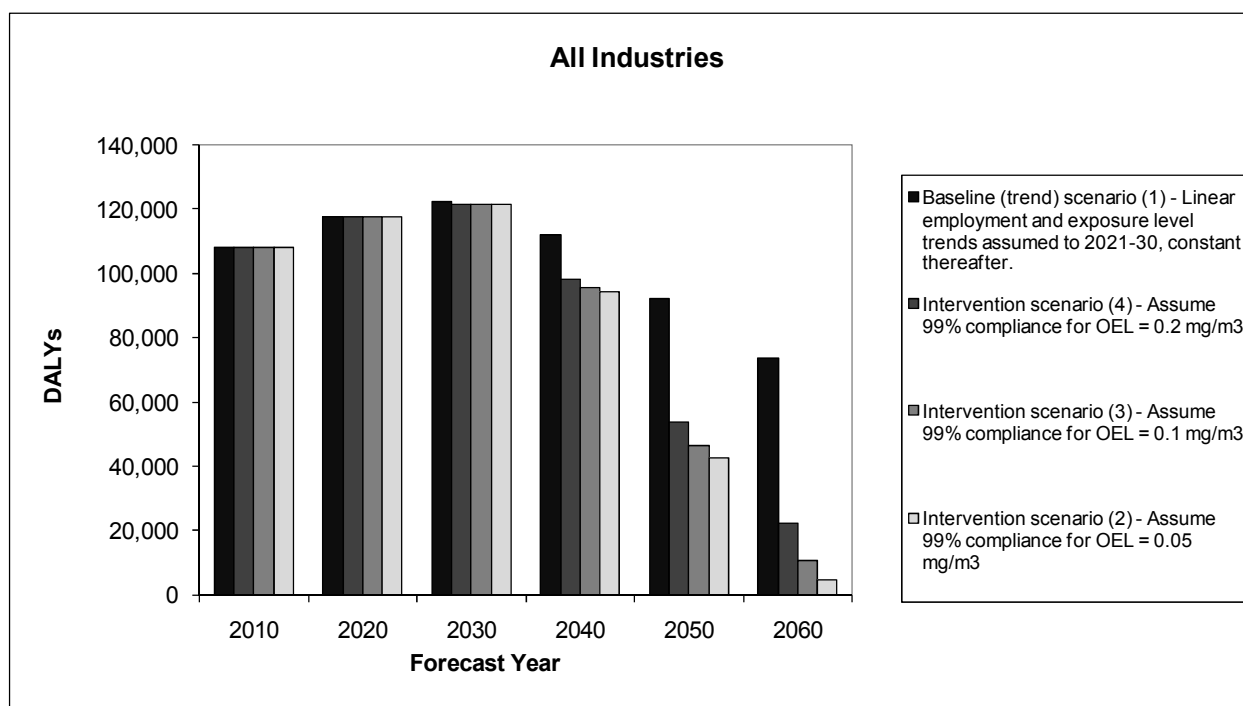


Figure 4.3 Occupation Attributable DALYs, Lung cancer

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 three groups of four columns (2030-2060). Attributable lung cancer deaths decrease from 6,870 in 2010 to 337 deaths in 2060 for scenario 2 (OEL of 0.05 mg/m³), 818 deaths for scenario 3 (OEL of 0.1 mg/m³) and 1,721 deaths for scenario 4 (OEL of 0.2 mg/m³).

In Table 8.4.1 in Appendix 8.4 are the estimated proportions exposed above the OELs to be tested, currently and as estimated under the baseline forecast scenario (1). Under the alternative change scenarios they behave as determined by the scenarios.

Full results are given in Appendix 8.4 for men plus women by country in Table 8.4.2 and Table 8.4.3. A breakdown of attributable numbers by industry is in Table 8.4.4 and Table 8.4.5. 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 (*Silica Report data.xls*) if required.

Table 4.2 Results for intervention scenarios (2) to (4), total EU (27 countries), men plus women

Scenario	All scenarios		Intervention scenario (2) – Full compliance for OEL = 0.05 mg/m3				Intervention scenario (3) – Full compliance for OEL = 0.1 mg/m3				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m3			
EU Total	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
<i>Numbers ever exposed</i>	21,865,037	22,763,939	23,950,199	24,817,021	25,434,592	25,884,091	23,950,199	24,817,021	25,434,592	25,884,091	23,950,199	24,817,021	25,434,592	25,884,091
<i>Proportion of the population exposed</i>	6.052%	5.979%	6.160%	6.301%	6.489%	6.740%	6.160%	6.301%	6.489%	6.740%	6.160%	6.301%	6.489%	6.740%
Lung cancer														
<i>Attributable Fraction</i>	2.453%	2.350%	2.201%	1.622%	0.720%	0.075%	2.202%	1.643%	0.787%	0.182%	2.204%	1.683%	0.912%	0.383%
<i>Attributable deaths</i>	6,870	7,715	8,327	6,822	3,194	337	8,330	6,911	3,489	818	8,336	7,077	4,043	1,721
<i>Attributable registrations</i>	7,645	8,493	8,998	7,204	3,307	345	9,001	7,297	3,613	838	9,007	7,473	4,187	1,763
<i>'Avoided' cancers</i>			49	1,336	3,893	5,479	46	1,243	3,588	4,985	40	1,067	3,014	4,061
<i>YLLs</i>	103,403	112,744	116,260	90,327	40,433	4,151	116,304	91,496	44,165	10,089	116,386	93,699	51,178	21,217
<i>DALYs</i>	108,005	117,793	121,523	94,477	42,320	4,347	121,568	95,701	46,227	10,565	121,654	98,005	53,566	22,217

4.1.2 Monetised health benefits

The possible health benefits (i.e. avoided healthcare costs and effects of having cancer) for the introduction of an EU wide OEL at 0.05, 0.1 and 0.2 mg/m³ are shown in Table 4.3. The change in cancer impacts over the first 30 years (2010-2040) are predominately the result of chronic impacts from past exposure.

The benefits of introducing an OEL in 2010 are most apparent from 2040 onwards (Table 4.3). There is estimated to be a significant benefit from introducing any of the proposed OELs with benefits being greatest with an OEL set at 0.05 mg/m³. The results are also illustrated in Figure 4.4.

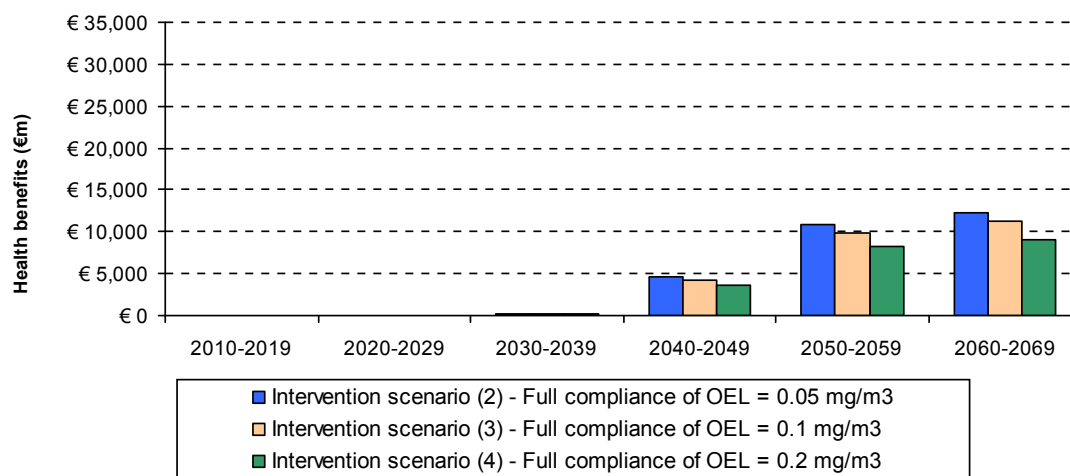
Table 4.3 Health benefits of intervention over time (Present Value – 2010 €m prices)

Costs by Gender (€m)	2010-2019	2020-2029	2030-2039	2040-2049	2050-2059	2060-2069	Totals
Intervention scenario (2) - Full compliance of OEL = 0.05 mg/m³							
Female	0 to 0	0 to 0	6 to 11	130 to 244	298 to 578	336 to 664	770 to 1497
Male	0 to 0	0 to 0	202 to 509	4433 to 11512	10471 to 27991	11982 to 32588	27088 to 72599
Total	0 to 0	0 to 0	208 to 520	4562 to 11756	10769 to 28569	12319 to 33251	27858 to 74096
Intervention scenario (3) - Full compliance of OEL = 0.1 mg/m³							
Female	0 to 0	0 to 0	6 to 10	121 to 228	276 to 535	308 to 607	710 to 1381
Male	0 to 0	0 to 0	188 to 474	4119 to 10704	9631 to 25764	10874 to 29597	24812 to 66540
Total	0 to 0	0 to 0	194 to 485	4240 to 10932	9907 to 26300	11181 to 30205	25522 to 67921
Intervention scenario (4) - Full compliance of OEL = 0.2 mg/m³							
Female	0 to 0	0 to 0	5 to 9	104 to 197	234 to 454	253 to 500	596 to 1160
Male	0 to 0	0 to 0	162 to 409	3530 to 9186	8066 to 21603	8817 to 24035	20575 to 55233
Total	0 to 0	0 to 0	167 to 418	3635 to 9383	8300 to 22057	9070 to 24535	21171 to 56393

Notes:

- All costs are presented in present value using a discount rate of 4%
- Totals may not match sums of female and male costs due to underlying small differences in raw data and rounding

Health benefits of introducing an EU OEL - Low benefit scenario



Health benefits of introducing an EU OEL - High benefit scenario

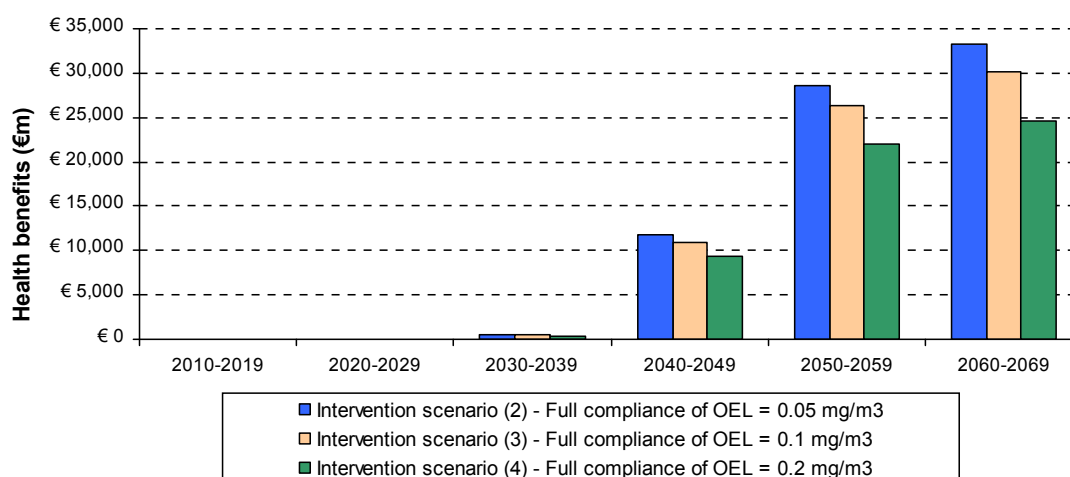


Figure 4.4 Health benefits over time of introducing an EU wide OEL (Present Value – 2010 €m prices)

These 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 by Member State are shown in Figure 4.5 (low scenario) and Figure 4.6 (high scenario), where France, Germany and Spain are predicted to particularly benefit from the OELs assuming full compliance²⁰.

The monetised benefits of a possible OEL for respirable crystalline silica are likely to affect men more than women given the industrial sectors most exposed to respirable crystalline silica. The industrial sector estimated to benefit most from a possible OEL

²⁰ The assumption of full compliance is a standard assumption used in EU Impact Assessments.

(and full compliance) is the construction sector. There are also notable impacts in the manufacture of other non-metallic mineral products. These two sectors are shown separately from the other affected sectors given the relative magnitude of potential benefits for these sectors (Figure 4.8 (low cost) and Figure 4.10 (high cost)). This is shown in the figures below (Figure 4.7, Figure 4.8, Figure 4.9 and Figure 4.10).

The Member State and industry groups that are predicted to benefit most from a possible OEL also vary at a gender level. This analysis is presented in the Appendix 8.5.

Total Health benefits (2010 - 2070) of different OELs - By Member State - Low benefit scenario

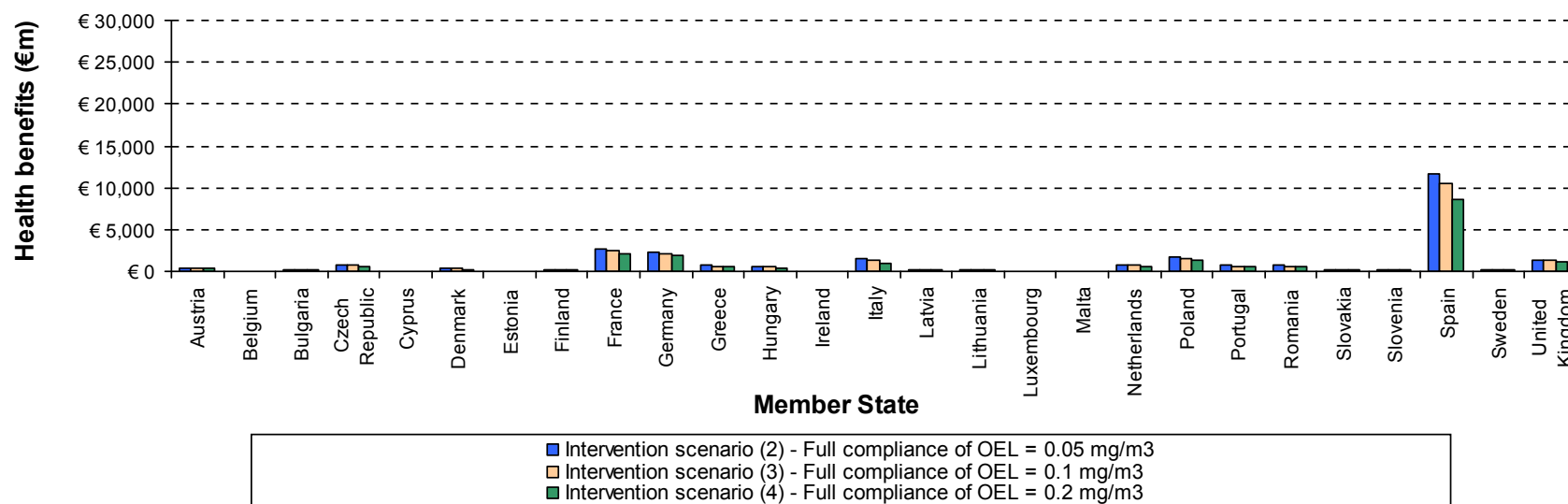


Figure 4.5 Total health benefits of introducing an EU wide OEL – By Member State – Low Scenario (Present Value – 2010 €m prices)

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

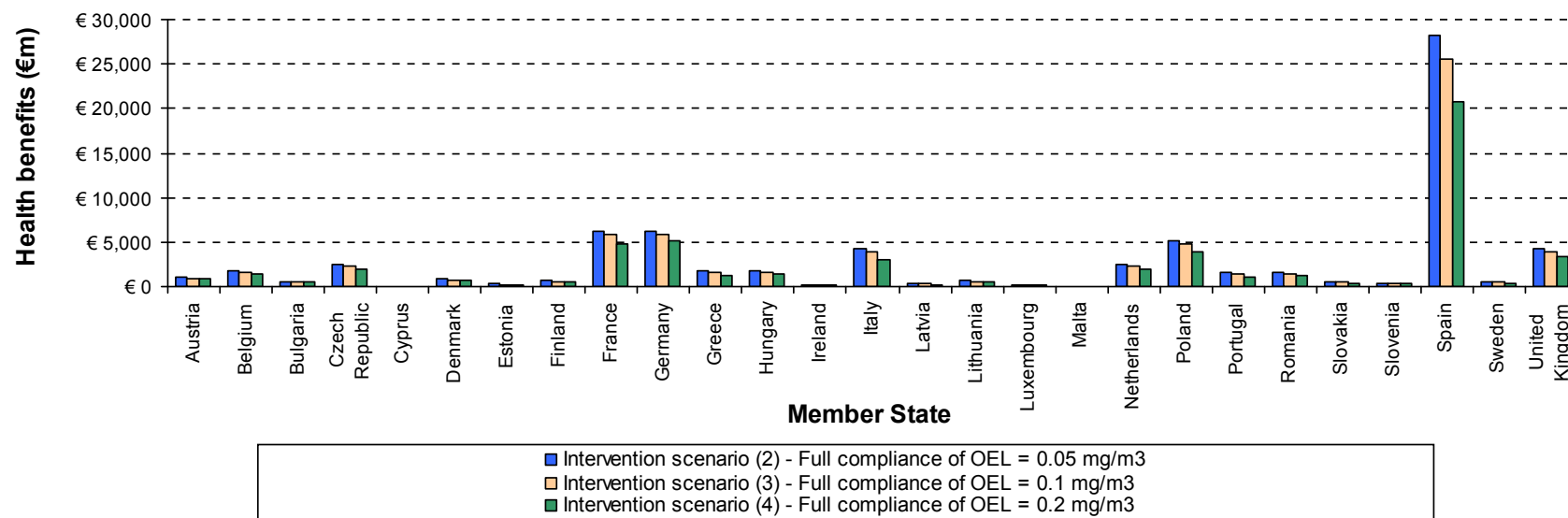


Figure 4.6 Total health benefits of introducing an EU wide OEL – By Member State – High Scenario (Present Value – 2010 €m prices)

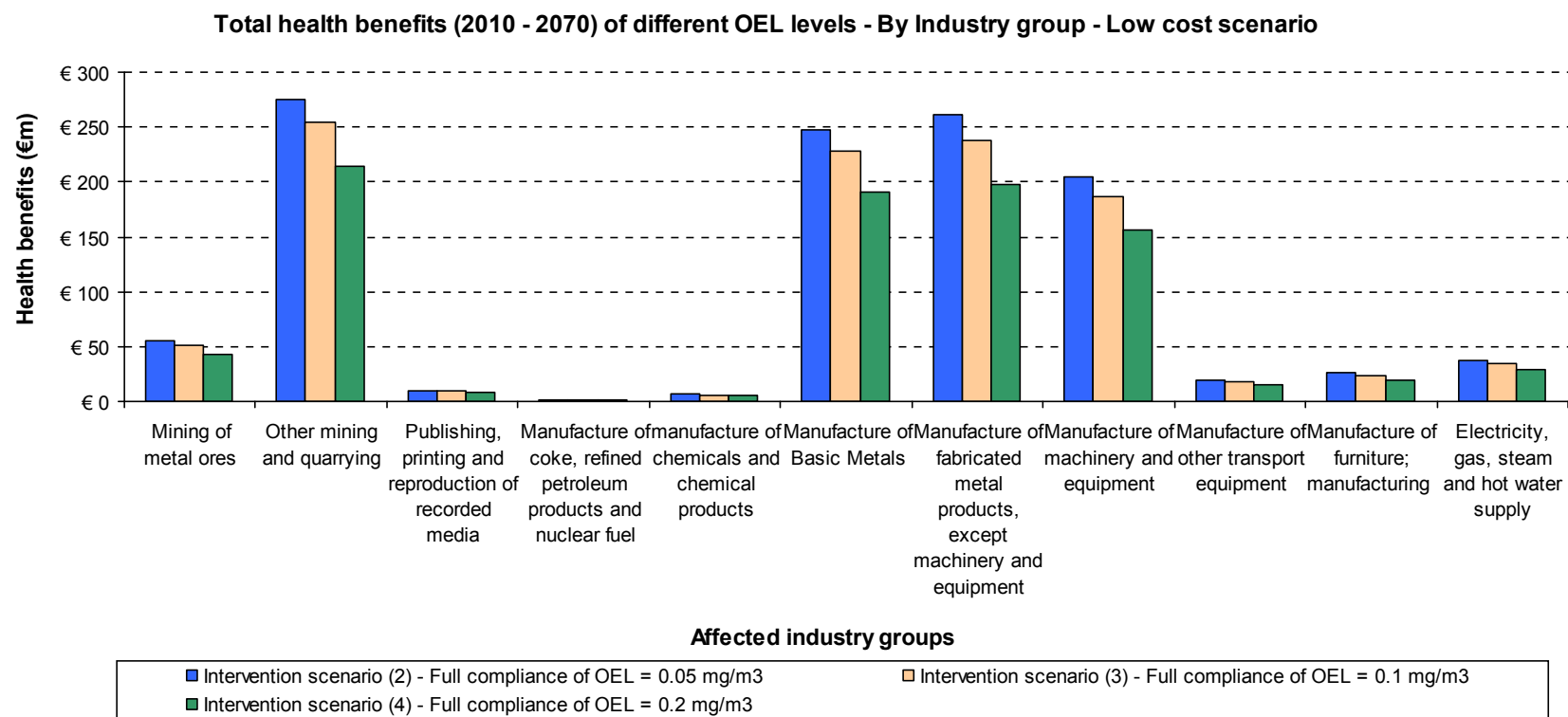


Figure 4.7 Total health benefits of introducing an EU wide OEL – By Industry Group – Low Scenario²¹ (Present Value – 2010 €m prices)

²¹ Charts exclude industries for which insignificant costs are estimated and for purposes of presentation the two industries with highest health costs are shown separately in Figure 4.8

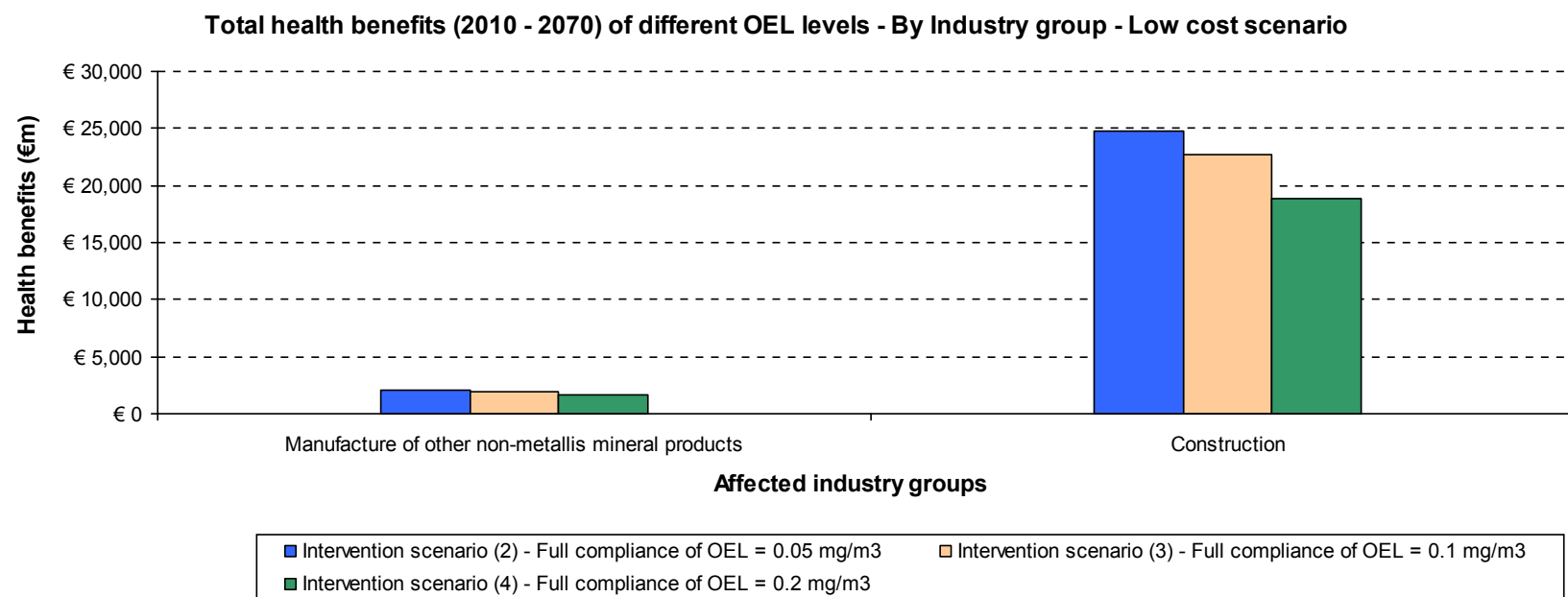


Figure 4.8 Total health benefits of introducing an EU wide OEL – By Industry Group – Low Scenario (Present Value – 2010 €m prices)

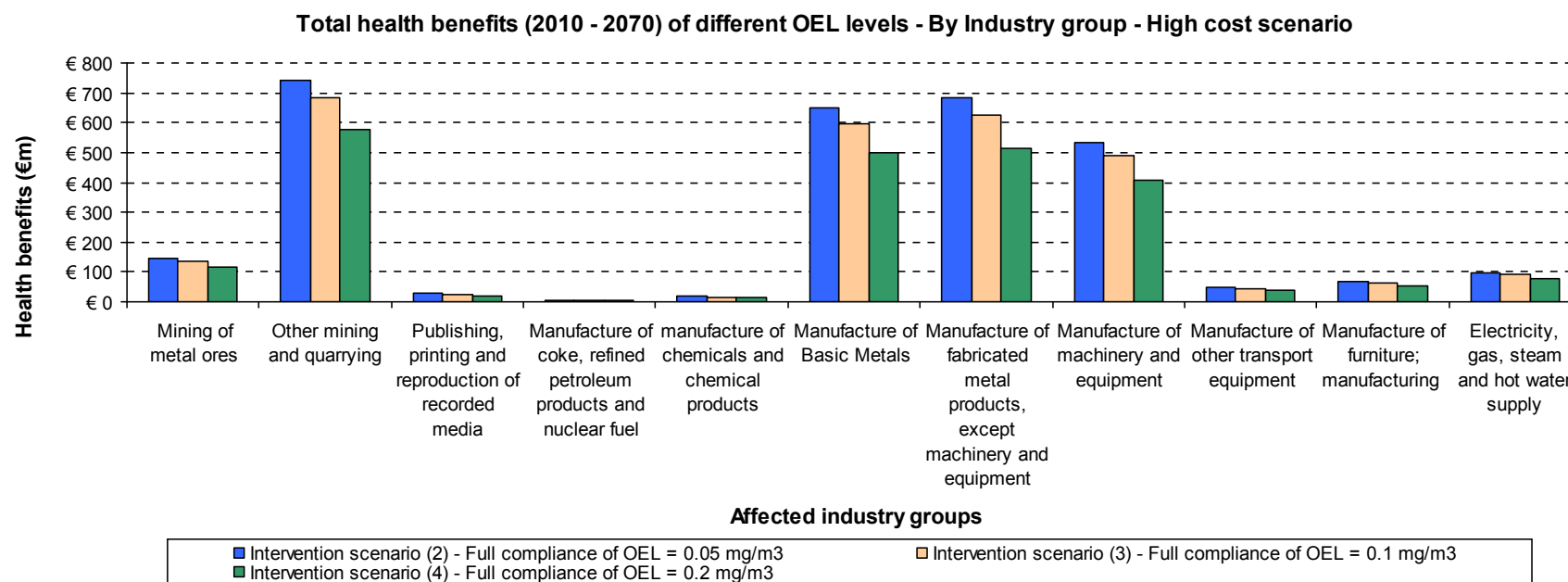


Figure 4.9 Total health benefits of introducing an EU wide OEL – By Industry Group – High Scenario²² (Present Value – 2010 €m prices)

²² Charts exclude industries for which insignificant costs are estimated and for purposes of presentation the two industries with highest health costs are shown separately in Figure 4.10

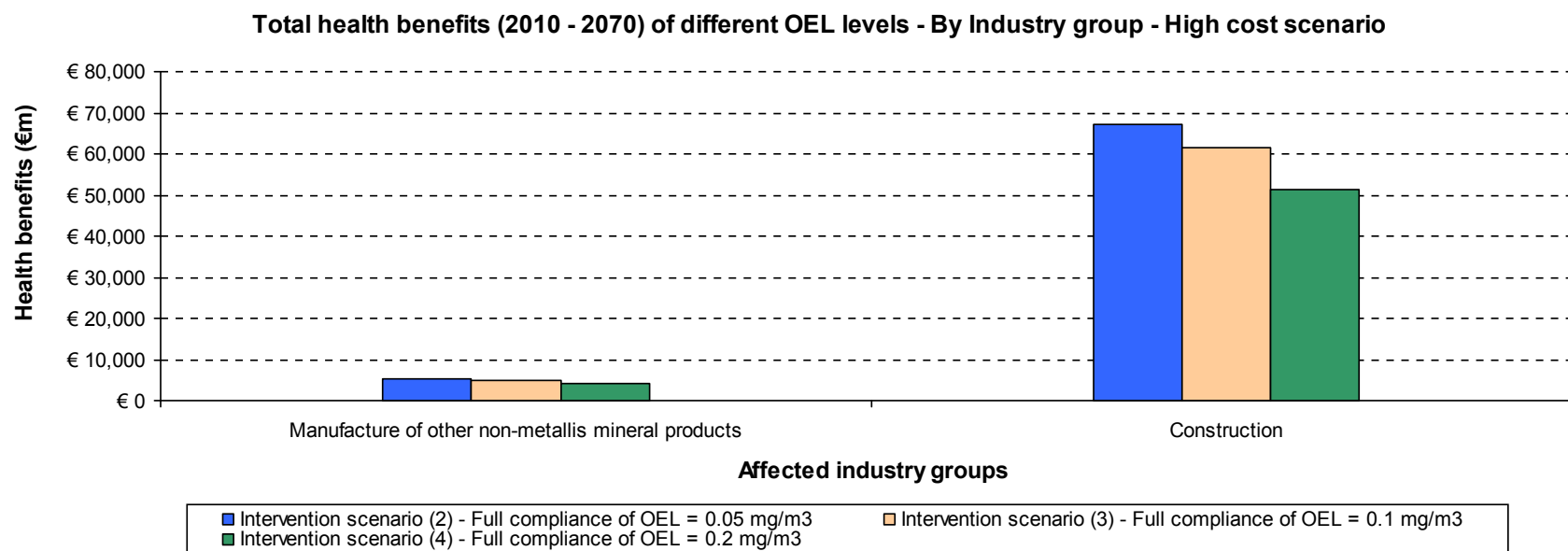


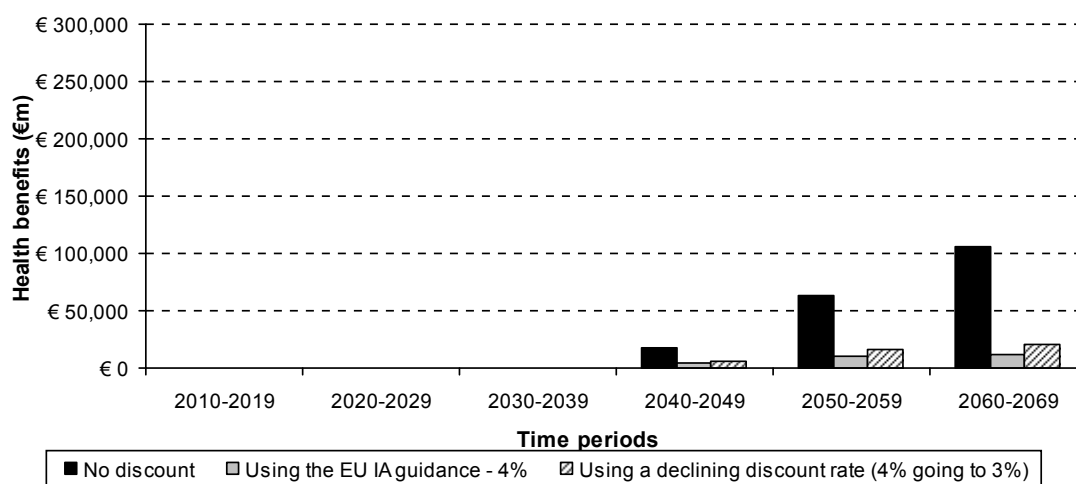
Figure 4.10 Total health benefits of introducing an EU wide OEL – By Industry Group – High Scenario (Present Value – 2010 €m prices)

As with the baseline scenario, in order to present all costs and benefits consistently in present 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 4.11 for introducing an OEL of 0.05mg/m³
- Figure 4.12 for introducing an OEL of 0.1mg/m³
- Figure 4.13 for introducing an OEL of 0.2mg/m³

Detailed tables are included in Appendix 8.6, with results presented using different discount rates.

Health benefits of Intervention option 2 - Low scenario



Health benefits of Intervention option 2 - High scenario

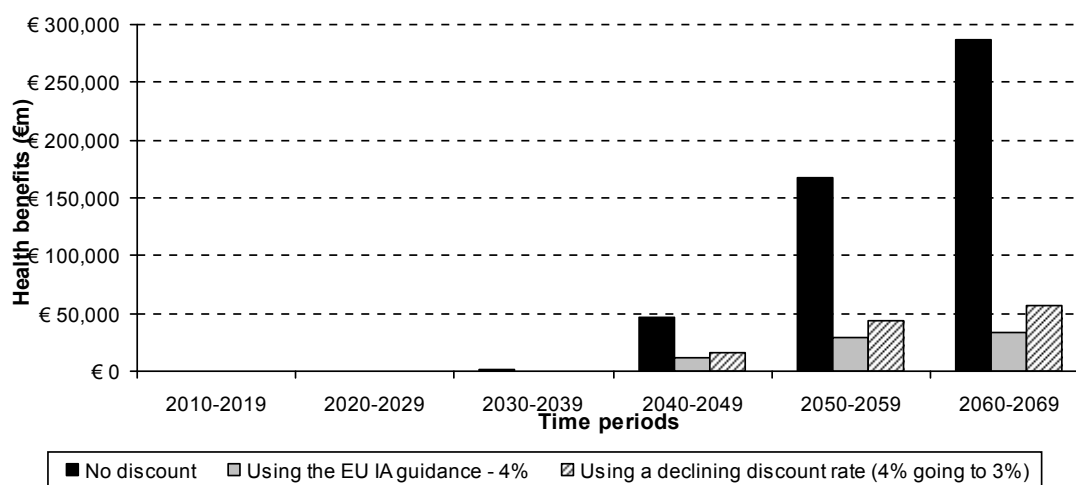
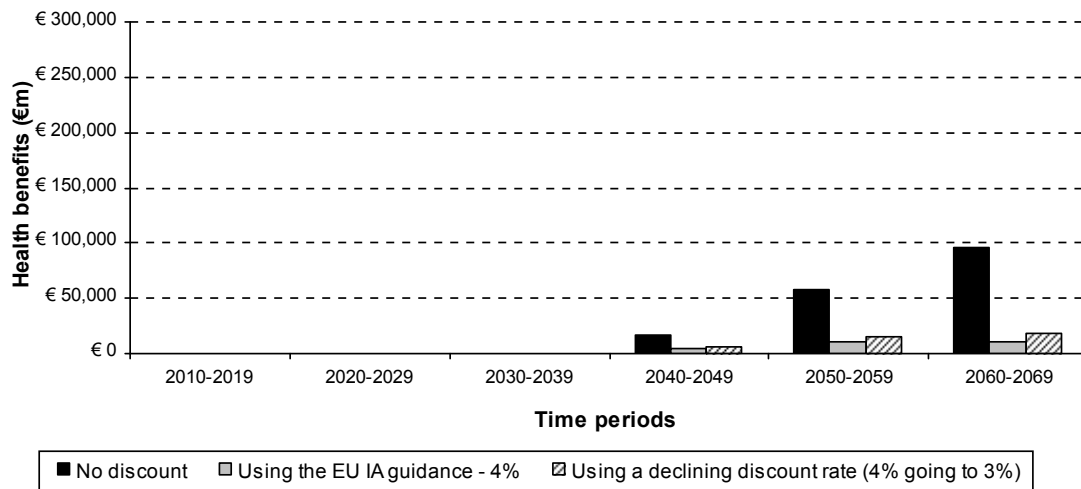


Figure 4.11 Impacts of discounting – Introducing an OEL of 0.05mg/m³

Health benefits of Intervention option 3 - Low scenario



Health benefits of Intervention option 3 - High scenario

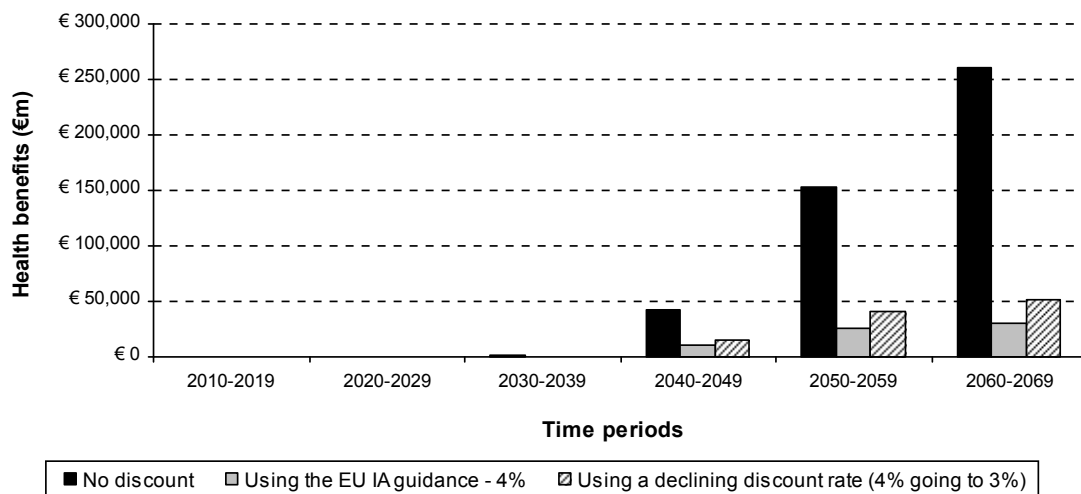
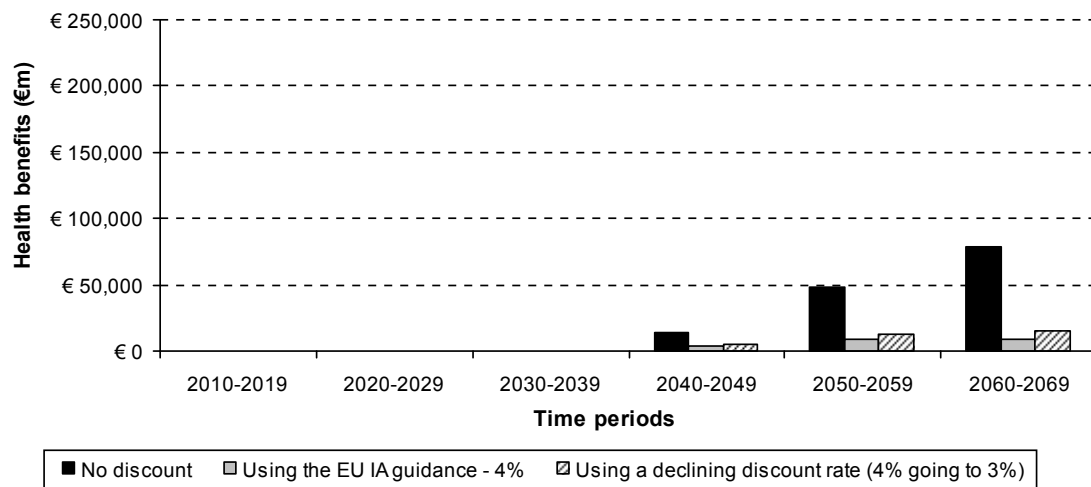


Figure 4.12 Impacts of discounting – Introducing an OEL of 0.1mg/m³

Health benefits of Intervention option 4 - Low scenario



Health benefits of Intervention option 4 - High scenario

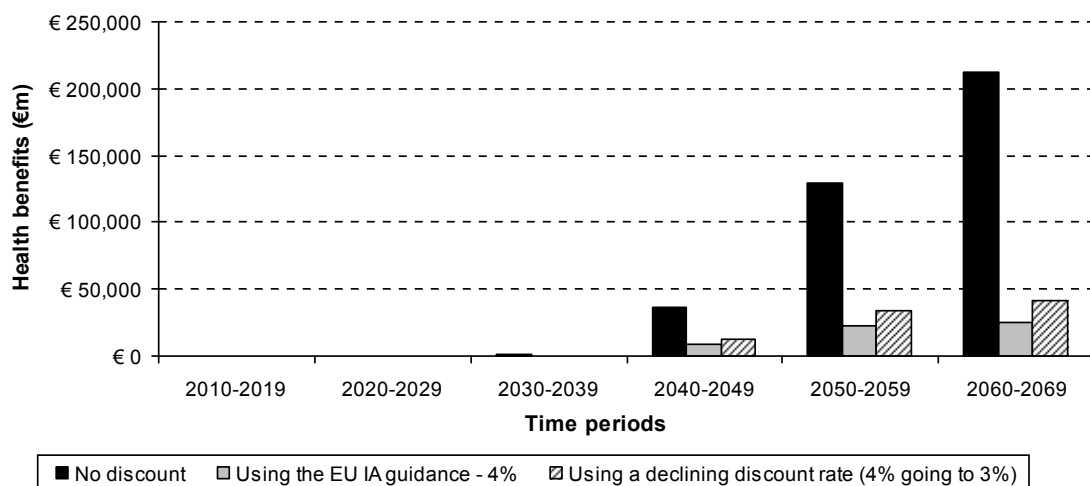


Figure 4.13 Impacts of discounting – Introducing an OEL of 0.2mg/m³

Since the benefits of introducing a more stringent OEL are mostly realised from 2040 onwards, the level of discounting has a significant impact on the overall size of health benefits. A limitation is that the benefits of any RMMs 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 lag period) which is not estimated in this study.

4.2 ECONOMIC IMPACTS

4.2.1 Operating costs and conduct of business

Compliance costs

Using the estimates of the number of enterprises affected as was shown in Table 3.8 it is possible to provide a broad estimate of the costs of compliance with each of the three possible OELs. Table 4.4 sets out the assumptions and cost estimates for each enterprise type. The cost estimates have been taken from the HSE (2003) report, converted to Euros and then uplifted to 2010 prices.

The total costs of compliance over the period 2010-2070 for each possible OEL are set out in Table 4.5. This time period is consistent with the health benefit estimates. The headline compliance costs are summarised below:

- OEL 0.05mg/m³ - The expected costs of compliance are estimated to be around €34bn over the period 2010-2070. The greatest costs are predicted to fall on the construction sector (€17bn) given the the number of enterprises thought to be affected (around 485,000). .
- OEL 0.1mg/m³ - The expected costs of compliance are estimated to be €19bn over the period 2010-2070. The greatest costs are predicted to fall on the construction sector (around €13bn) given the number of enterprises thought to be affected (around 370,000).
- OEL 0.2mg/m³ - The expected costs of compliance are estimated to be €10bn over the period 2010-2070. The greatest costs are predicted to fall on the construction sector (around €8bn) given the number of enterprises thought to be affected (around 250,000).

Table 4.4 Approach to compliance – assumptions and costs per enterprise affected

Sector	OEL = 0.2 mg/m ³	OEL = 0.1 mg/m ³	OEL = 0.05 mg/m ³
Quarry	Additional monitoring (10 analyses) at an annual cost of around €1.8k per enterprise	Additional refuge and additional air-conditioned ventilated cab for a large drilling rig. Additional monitoring (10 analyses) The total capital cost per enterprise is estimated to be €513k every 20 years and an annual cost of €27.5k.	Additional refuge and additional air-conditioned ventilated cab for a large drilling rig. Additional monitoring (10 analyses) The total capital cost per enterprise is estimated to be €513k every 20 years and an annual cost of €27.5k
Construction	Although the HSE report suggests minimal costs of compliance for the UK to meet an OEL of 0.2 mg/m ³ based exposure results there is estimated to be exposures above the OEL. Therefore the same measures to the 0.1 mg/m ³ OEL are assumed (see box to the right).	Most enterprises would require the use of water suppression (e.g. on cutting equipment). This is thought to be a small cost. Some workers would require the use of appropriate PPE and appropriate training procedures will need to be developed. It is assumed that costs will be €1,500 per enterprise and predominately related to PPE and training.	Most enterprises would require the use of water suppression (e.g. when using cutting discs to avoid dust being formed). This is thought to be a small cost. Some workers would require the use of appropriate PPE and appropriate training procedures will need to be developed. It is assumed that costs would be €1,500 per enterprise and predominately related to PPE and training.
Foundry	Although the HSE report suggests minimal costs of compliance for the UK to meet an OEL of 0.2 mg/m ³ based exposure results there is estimated to be exposures above the OEL. Therefore the same measures to the 0.1 mg/m ³ OEL are assumed (see box to the right).	Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €18k and last 20 years. There would also be an operating cost of around €2.7k mainly associated with LEV use and appropriate training.	Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €18k and last 20 years. There would also be an operating cost of around €2.7k mainly associated with LEV use and appropriate training. Around 50% of affected enterprises would also require RPE equipment. This is estimated to incur a total annual capital and operating cost of around €14k
Ceramics	Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €18k and last 20 years. There would also be an operating cost of	Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €37k and last 20 years. There would also be an operating cost of	Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €37k and last 20 years. There would also be an operating cost of around

Sector	OEL = 0.2 mg/m ³	OEL = 0.1 mg/m ³	OEL = 0.05 mg/m ³
Brick Manufacture	around €2.7k mainly associated with LEV use and appropriate training. Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €183k and last 20 years. There would also be an operating cost of around €11k mainly associated with LEV use and appropriate training.	around €5.5k mainly associated with LEV use and appropriate training. Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €183k and last 20 years. There will also be an operating cost of around €11k mainly associated with LEV use and appropriate training.	€5.5k mainly associated with LEV use and appropriate training. Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €183k and last 20 years. There would also be an operating cost of around €11k mainly associated with LEV use and appropriate training. Around 50% of affected <i>workers</i> would also require RPE equipment. This is estimated to incur a total annual capital and operating cost of around €1.7k per worker
Silica Sand Production & Silica Flour Production	<u>Silica Sand Production</u> Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €73k and last 20 years. There would also be an operating cost of around €5.5k mainly associated with LEV use and appropriate training. <u>Silica Flour Production</u> Capital costs of around €3m based on installing big kits for bagging areas and an operating cost of €150k.	<u>Silica Sand Production</u> Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €73k and last 20 years. There would also be an operating cost of around €5.5k mainly associated with LEV use and appropriate training. <u>Silica Flour Production</u> Capital costs of around €3m based on installing big kits for bagging areas and an operating cost of €150k.	<u>Silica Sand Production</u> Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €220k and last 20 years. There would also be an operating cost of around €13k mainly associated with LEV use and appropriate training. <u>Silica Flour Production</u> Capital costs of around €5.7m based on installing big kits for bagging areas and an operating cost of €285k.
Scouring Powders	€9k capital cost of a bag baler (no operating cost assumed) which is assumed to last 20 years. €18k capital cost of extracted booth for splitting which is assumed to last 20 years and operating cost of €9k. There is also assumed to be additional monitoring and training costs of around €2k per year.	€9k capital cost of a bag baler (no operating cost assumed) which is assumed to last 20 years. €18k capital cost of extracted booth for splitting which is assumed to last 20 years and operating cost of €9k. There is also assumed to be additional monitoring and training costs of around €2k per year.	€9k capital cost of a bag baler (no operating cost assumed) which is assumed to last 20 years. €18k capital cost of extracted booth for splitting which is assumed to last 20 years and operating cost of €9k. There is also assumed to be additional monitoring and training costs of around €2k per year. Affected enterprises would also require

Sector	OEL = 0.2 mg/m ³	OEL = 0.1 mg/m ³	OEL = 0.05 mg/m ³
Glass Polishing	Capital cost of around €55k every 20 years and annual operating cost around €3k from the use of extracted changing room as well as monitoring costs every 2 years.	Capital cost of around €55k every 20 years and annual operating cost around €3k from the use of extracted changing room as well as monitoring costs every 2 years.	RPE equipment. This is estimated to incur a total annual capital and operating cost of around €7k Capital cost of around €55k every 20 years and annual operating cost around €3k from the use of extracted changing room as well as monitoring costs every 2 years.
Composites	Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €18k and last 20 years. There would also be an operating cost of around €2.7k mainly associated with LEV use and appropriate training.	Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €18k and last 20 years. There would also be an operating cost of around €2.7k mainly associated with LEV use and appropriate training.	Local Exhaust Ventilation (LEVs) would be required which were estimated to cost around €18k and last 20 years. There would also be an operating cost of around €2.7k mainly associated with LEV use and appropriate training.
Jewellery casting	Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €18k and last 20 years. There would also be an operating cost of around €2.7k mainly associated with LEV use and appropriate training. Affected <i>workers</i> would also require RPE equipment. This was estimated to incur a total annual capital and operating cost of around €7k per worker	Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €18k and last 20 years. There will also be an operating cost of around €2.7k mainly associated with LEV use and appropriate training. Affected <i>workers</i> would also require RPE equipment. This was estimated to incur a total annual capital and operating cost of around €7k per worker	Local Exhaust Ventilation (LEVs) would be required which was estimated to cost around €18k and last 20 years. There would also be an operating cost of around €2.7k mainly associated with LEV use and appropriate training. Affected <i>workers</i> would also require RPE equipment. This is estimated to incur a total annual capital and operating cost of around €7k per worker
Stonemasonry	It is assumed that 10% of workers exposed would need to use downdraught extraction in addition to using wet cutters and polishers. The average annual cost per <u>worker</u> estimated to be €385 (capital and operating costs).	It is assumed that 10% of workers exposed would need to use downdraught extraction in addition to using wet cutters and polishers. The average annual cost per <u>worker</u> is estimated to be €385 (capital and operating costs). Additionally there would be additional monitoring costs for 20% of workers exposed. The average annual cost per <u>worker</u> estimated to	It is assumed that 10% of workers exposed would need to use downdraught extraction in addition to using wet cutters and polishers. The average annual cost per <u>worker</u> is estimated to be €385 (capital and operating costs). Additionally there would be additional monitoring costs for 50% of workers exposed. The average annual cost per <u>worker</u> estimated to cost €917 per year.

Sector	OEL = 0.2 mg/m ³	OEL = 0.1 mg/m ³	OEL = 0.05 mg/m ³
		cost €367 per year.	Additionally 10% of workers would need to use special booths at a capital cost of around £18k which are assumed to last 20 years.
Manufacture of coke, refined petroleum products and nuclear fuel	Insufficient data available to estimate costs	Insufficient data available to estimate costs	Insufficient data available to estimate costs
Manufacture of chemicals and chemical products	Insufficient data available to estimate costs	Insufficient data available to estimate costs	Insufficient data available to estimate costs
Electricity, gas, steam and hot water supply	Insufficient data available to estimate costs	Insufficient data available to estimate costs	Insufficient data available to estimate costs
Calculations and assumptions based on the HSE (2003) report. Figures in the above table have not been rounded but are subject to uncertainty.			

Table 4.5 Total costs of compliance over the period 2010-2070

Sector	Total cost per enterprise over the period 2010-2070 (NPV) - €k			Total cost to sector over the period 2010-2070 (NPV) - €m		
	0.2 mg/m ³	0.1 mg/m ³	0.05 mg/m ³	0.2 mg/m ³	0.1 mg/m ³	0.05 mg/m ³
Quarry	43	1,502	1,502	11	1,590	4,534
Construction	35	35	35	8,764	12,915	17,148
Foundry	95	95	262 ¹	80	309	2,262
Ceramics	95	191	191	167	899	1,775
Brick Manufacture	564	564	565 ²	495	1,331	2,634
Silica Sand Production & Silica Flour Production ³	334	334	823	16	70	495
Scouring Powders	305	305	472	267	719	2,198
Glass Polishing	167	167	167	147	394	778
Composites	95	95	95	167	450	888
Jewelry casting	262	262	262	9	33	89
Stonemasonry	16	108	221	14	255	1,030
Manufacture of coke, refined petroleum products and nuclear fuel	NE	NE	NE	NE	NE	NE
Manufacture of chemicals and chemical products	NE	NE	NE	NE	NE	NE
Electricity, gas, steam and hot water supply	NE	NE	NE	NE	NE	NE
Total cost over the period 2010-2070	-	-	-	10,137	18,966	33,830

Notes: NE = Not estimated due to insufficient cost data

¹ – This is the average cost for a foundry over the period 2010-2069 – . It was assumed that half of affected enterprises would need additional RPE measures

² – This is the average cost for a brick manufacturer over the period 2010-2069 – . It was assumed that half of affected workers would need additional RPE measures

³ – It is assumed 99% of enterprises affected are involved in silica sand production and 1% of enterprises affected are involved in silica flour production, based on an assumption that silica flour production occurs at silica quarrying sites and assuming that the ratio of 1% used in the HSE study holds true for the rest of EU.

Conduct of employers

The introduction of an EU-wide OEL set at or below $0.2\text{mg}/\text{m}^3$ would require certain companies to reorganise their workplace to ensure that exposure to RCS emissions is minimised. There may also be additional training and authorisation of personnel handling the substance 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, cleaning procedures and safety instructions). There is unlikely to be any significant change for those already adhering to the NEPSI good practice guide, although the introduction of an OEL of $0.05\text{ mg}/\text{m}^3$ could require workers to be constantly wearing RPE as levels of exposure will be close to the natural background level of RCS in air.

Potential for closure of companies

It can be seen from section 3.2.3 that the majority of enterprises affected are small, with fewer than 9 employees. With the introduction of an OEL of 0.05 and $0.1\text{mg}/\text{m}^3$ the costs of compliance per enterprise (see Table 4.4) may be very expensive for a large proportion of the sectors affected relatively to possible funds available to finance since investments.

This increase in costs and any subsequent reduction in profits could lead to the closure of some of the affected enterprises as firms may not be able to get access to loans to pay for the necessary investment. Firms may also decide that the long run costs incurred could be avoided (or at least reduced) by relocating operations to outside of the EU. Where activities are dependant on being in the EU (e.g. construction at site, building work) relocation is not a viable option. However it might be possible to pass through additional costs to consumers to some extent.

Whilst there are costs of compliance with an OEL of $0.2\text{mg}/\text{m}^3$ (as shown in Table 4.5) for many sectors, the costs are not thought to be as high relative to possible funds available to finance reduced exposure, although again SMEs are likely to be worse off. Therefore the risks of closures are expected to be much lower for an OEL of $0.2\text{mg}/\text{m}^3$ and could be reduced if there were possible financial assistance for SMEs.

The potential risk of closure from an affordability perspective reduces as the size of firm increases, as the capital compliance costs are likely to be smaller as a proportion of the average operating surplus (a measure of profitability). It should be noted that this is partly because the capital compliance cost estimated are assumed to be the same for all firm sizes. In reality compliance costs will vary to some extent by firm size and the ratio of compliance costs to operating surplus will therefore be smaller for smaller firms and larger for larger firms.

Potential impacts for specific types of companies

The annual cost of compliance under an OEL of $0.2\text{ mg}/\text{m}^3$ is not expected to result in any specific impacts for specific types of companies affected, although again SMEs may be worse off (However, it is likely that very small firms are not manufacturers and therefore are not incurring capital costs of equipment). There is, however, expected to be a proportionately very high cost of compliance with an OEL of 0.05 and $0.1\text{mg}/\text{m}^3$ for those SMEs that will need to install exposure control measures. Therefore there is a genuine risk that SMEs could close rather than incur the costs of compliance with the more stringent OEL options.

Administrative costs to employers and public authorities

The following table (Table 4.6) describes the administrative burden to employers by the substance being included on the Carcinogens Directive.

Table 4.6 Administrative burdens to employers

Type of administrative cost	Relevant article(s)	Type of cost	Significance
1. Familiarisation costs with the Directive and requirements for full compliance	-	Individual(s) responsible for health and safety and training will need to familiarise themselves with the requirements of the Directive. This is largely a one-off cost with some periodic costs for training of new trainers.	Low
2. Time for R&D and exploration of suitable alternatives to reduce and replace use of the substance so far as technically feasible	4 – Reduction and replacement	Largely one-off cost but findings may need to be updated annually. Many large size firms are likely to already be investing in R&D and alternatives.	Low
3. Document findings		As part of the CLP Regulation (EC) No 1272/2008 and Chemicals Agents Directive (CAD) risks must be eliminated or reduced to a minimum. Substitution is preferred and, if that isn't possible, there is a hierarchy of controls (e.g. workplace changes, general protective equipment, PPE, etc).	
4. Change in practice to use of closed systems when using the substance.	5 – Prevention and reduction of exposure	These costs are already estimated in the cost of compliance section. This will only affect those firms that do not have or use closed systems	Estimated elsewhere
5. Upon request, employers will need make information available to competent authorities on activities/processes carried out and why the substance is used, quantities used, number of workers exposed and protective measures and equipment used to reduce exposure	6 – Information for the competent authority	As this information is only required upon request (with the frequency of requests unknown), the administrative costs are likely to be low given much of this information should be readily available to the firms concerned.	Low

Type of administrative cost	Relevant article(s)	Type of cost	Significance
6. Develop/update health and safety and best practice guidance for: <ul style="list-style-type: none"> Minimising use and exposure to workers to the substance Redesign work processes and engineering controls to avoid/minimise release of carcinogens or mutagens Hygiene measures, in particular regular cleaning of floors, walls and other surfaces Information for workers Warnings and safety signs Drawing up plans to deal with emergencies likely to result in abnormally high exposure 	5 – Prevention and reduction of exposure 7 – Unforeseen exposure 8 – Foreseeable exposure 9 – Access to risk areas 10 – Hygiene and individual protection	Some firms may only incur a one-off cost from updating existing guidance and training material. Some firms may need to redesign work practices to minimise exposure to workers and the number of workers exposed. The costs of implementing controls on exposure (such as LEV or PPE) are already estimated in the costs of compliance section. Firms should already be doing many of these good practices as part of the CLP Regulation and the CAD.	Low-Medium
7. Additional costs of training new and existing staff in line with requirements of the Directive	11 – Information and training of workers	Largely one-off cost but training may need to be repeated periodically if necessary.	Low/medium
8. Additional costs of making information available to employees	12 – Information for workers	Periodic training should typically be carried out as best practice so largely one-off cost of updating training material.	
9. Consultation with employees on compliance with the Directive	13 – Consultation and participation with workers		
9. Record keeping for 40 years of list of workers engaged in activities where they are exposed to the substance and individual medical records when health surveillance is carried out.	15 – Record keeping Reference to 12(c) and 14(4)	Likely to be a small annual cost to ensure personnel files are kept up to date and information is correctly stored.	Low

Note: Readers should consult the Directive for the official wording around specific requirements. This table provides only a summary of what are perceived to be the most significant administrative requirements of the Directive. Grading of the significance of impacts is subjective and is based on professional judgement.

The following table (Table 4.7) describes the administrative burden to competent authorities by the substance being included on the Carcinogens Directive.

Table 4.7 Administrative burdens to Competent Authorities

Type of administrative cost	Relevant article(s)	Type of cost	Significance
1. Familiarisation costs with the Directive and requirements for full compliance	-	Individual(s) responsible will need to familiarise themselves with the requirements of the directive. This is largely a one-off cost with some periodic costs for new/replacement staff.	Low
2. Establishing, in accordance with national laws and/or practice, arrangements for carrying out relevant health surveillance of workers for whom the results of the assessment referred to in Article 3(2) reveal a risk to health or safety.	14 – Health Surveillance	The annual costs will depend on the number visits undertaken.	Low – High
3. Communication with the Commission on provisions in national law to enforce the Directive.	19 – Notifying the commission 20 – Repeal	Largely one-off cost of transposing the Directive into national law	Medium (one-off cost)
4. Time and costs of implementing Directive into national law (consultation process)			

Note: Readers should consult the Directive for the official wording around specific requirements. This table provides only a summary of what are perceived to be the most significant administrative requirements of the Directive. Grading of the significance of impacts is subjective and is based on professional judgement.

Third countries

An OEL of 0.2 mg/m³ is not expected to result in any significant impacts to third countries relative to the baseline scenario. However there is a risk that production could move out of the EU as a result of the need to comply with more stringent OELs where there is a very high cost of compliance with an OEL of 0.05 and 0.1mg/m³ to SMEs as compared to operating surplus (or turnover, for example). As noted from industry consultation²³, there is a risk of increased emissions in third countries from increased transport and production from companies outside of the EU.

4.2.2 Impact on innovation and research

Given the number of sectors affected and the costs associated with compliance, there is expected to be a significant impact on innovation and research. In the event that a stringent OEL is introduced, companies would be under greater pressure to minimise costs and would be expected to seek out the least cost approach to compliance including how they use RCS and products containing RCS.

²³ Communication with Industrial Minerals Association (IMA-Europe)

Equally it could be argued that as the industry is predominately made up of smaller companies it is possible that these companies would tend to adopt products and techniques that are already being applied within other parts of the industry in order to comply with an EU-wide OEL. If this were true, then the impacts on innovation and research will be less significant.

An EU-wide OEL could, however, be expected to increase the dissemination of improved technologies and production methods²⁴. The potential volume of additional demand for abatement measures required across the EU such as ventilation systems may also stimulate investment in R&D to produce more cost-effective systems.

4.2.3 Macroeconomic impact

Short term spending on risk management measures may also be good for the economy as equipment manufacturers (e.g. ventilation systems, booths, bag balers), 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 R&D, meaning the wider economy would not benefit from increased spending).

With fewer life years lost and cancer registrations, there should be a benefit to the economy 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 greater consumption due to fewer premature deaths and greater taxes raised.

However this is not expected to have a significant macroeconomic impact given the costs of compliance are small (e.g. €10-34bn over 60 years) compared to the total value of goods and services in the manufacturing sector along which was €5trillion in 2006 alone.

4.3 SOCIAL IMPACTS

4.3.1 Employment and labour markets

In the event that one of the possible OELs is introduced, job patterns may be altered as it is recognised that in order to meet each possible OEL, behavioural change amongst employees and updating health and safety training will be required. Introducing an EU wide OEL of 0.05 or 0.1mg/m³ is likely to have a much more significant impact (i.e. cost of compliance) on SMEs compared to an OEL of 0.2mg/m³ and there is a genuine risk that the costs of compliance could lead to firms closing down if the costs can not be passed through to consumer prices.

The use of control measures such as closed systems reduces risks of human exposure in a way that should not inhibit production. There should therefore be improvements in working conditions. The use of wet cleaning and RPE should also reduce risks of human exposure, although their use may potentially slow down operations or be perceived to do so.

²⁴ There is insufficient information available to assess if this has occurred in Member States when OELs have been introduced at a national level

4.3.2 Changes in end products

This is not expected to be changes in end products from the introduction of an EU-wide OEL relative to the baseline scenario the risk management measures should not affect the characteristic of the products being produced. However, the increased level of regulatory control may encourage the development and replacement of products with alternative (lower-risk) substances.

4.4 ENVIRONMENTAL IMPACTS

Very little information is available regarding the ecotoxicity of respirable crystalline silica. Silica-bearing deposits are ubiquitous. Quartz, from which most silica deposits are derived, is hard, inert, and practically insoluble. Owing to the ubiquity of silica in the natural environment and in various everyday products, environmental exposure is inevitable (NTP, 1998).

No significant environmental effects are expected due to the chemical inertness and slow solubility of the substance. Crystalline silica is resistant to decomposition by weathering, biological activity and further oxidation.

Discharges to the aquatic environment are unlikely to have any toxic effect on aquatic life but may cause physical problems due to the suspension of the material in water and silting. Large aquatic discharges may lead to localised adverse physical effects to aquatic organisms. Such impacts could be reduced, depending on the compliance methods adopted.

Terrestrial mammals and birds exposed to quartz in the natural environment, especially in desert or coastal areas, show pathological lesions that are similar to those seen in humans with silicosis (CICAD, 2000). Rats, hamsters, guinea-pigs, monkeys, and mice exposed to quartz under experimental conditions develop lung conditions and nodules similar to those found in humans (CICAD, 2000)

The achievement of the possible OELs via the measures described in this report could lead to more direct emissions of respirable crystalline silica to the environment (through ventilation), but probably not to an increased overall environmental burden and therefore would not increase the level of environmental harm. Having said this, a quantitative assessment of the amounts of respirable crystalline silica releases into the environment as a result of the measures that would be put in place to achieve the OEL has not been done for the purposes of this study.

The increased use of LEV might lead to additional demand for electricity. This, in turn, might result in additional GHG emissions. A quantitative assessment of the additional energy use has not been undertaken for the purposes of this study. The EEA²⁵ estimate that the external (damage) costs of costs associated with energy production which are not reflected in electricity prices but which society must bear ranges from 1.8-5.9 Eurocent/kWh (2005 prices). The external cost of electricity takes into consideration:

- climate change damage costs associated with emissions of CO₂

²⁵ EN35 External costs of electricity production <http://www.eea.europa.eu/data-and-maps/indicators/en35-external-costs-of-electricity-production-1>

- damage costs (such as impacts on health, crops etc) associated with other air pollutants (NO_x, SO₂, NMVOCs, PM10, NH₃); and
- other non-environmental social costs for non-fossil electricity-generating technologies.

5 COMPARISON OF OPTIONS

The main identified impacts of introducing an OEL at 0.2mg/m³, 0.1mg/m³ and 0.05mg/m³ are shown in the tables below.

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

Type of impact	Baseline Scenario		Introduce OEL=0.05mg/m ³		Introduce OEL=0.1mg/m ³		Introduce OEL=0.2mg/m ³	
	Costs	Benefits	Costs	Benefits	Costs	Benefits	Costs	Benefits
Health	<p>As set out in section 2.5, the health costs of cancer (lung) over the period 2010-70 are estimated to be:</p> <ul style="list-style-type: none"> - Females: €7bn to €13bn - Males: €185bn to €481bn - Total: €192bn to €493bn <p>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).</p>	<p>It is assumed that exposures fall by 7% 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.</p>	<p>None relative to the baseline scenario - 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.</p>	<p>Health benefits of the proposed OELs have been analysed at the Member State and industrial sector level. The results showed that the benefits of introducing an OEL in 2010 are most apparent to the construction 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 at €28-74bn over the period 2010-2070.</p>	<p>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.</p>	<p>The monetised benefits were estimated at €26-68bn over the period 2010-2070.</p>	<p>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.</p>	<p>The monetised benefits were estimated at €21-56bn over the period 2010-2070.</p>
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 impact	Baseline Scenario		Introduce OEL=0.05mg/m ³		Introduce OEL=0.1mg/m ³		Introduce OEL=0.2mg/m ³	
	Costs	Benefits	Costs	Benefits	Costs	Benefits	Costs	Benefits
Economic	Exposure is estimated to decline by 7% per year and therefore firms will already be incurring costs for exposure control measures without intervention. However these costs may be incurred later over time without further intervention.	Ventilation system and RPE manufacturers and suppliers should benefit from increased demand over time for exposure control measures.	The expected costs of compliance are estimated to be around €34bn over the period 2010-2070. The greatest costs are predicted to fall on the construction sector (€17bn) given the the number of enterprises thought to be affected (around 485,000).	Similar benefits to the baseline scenario	<u>OEL 0.1mg/m³</u> - The expected costs of compliance are estimated to be €19bn over the period 2010-2070. The greatest costs are predicted to fall on the construction sector (around €13bn) given the number of enterprises thought to be affected (around 370,000).	Similar benefits to the baseline scenario	The expected costs of compliance are estimated to be €10bn over the period 2010-2070. The greatest costs are predicted to fall on the construction sector (around €8bn) given the number of enterprises thought to be affected (around 250,000).	Similar benefits to 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 5.3 Comparison of social impacts by scenario

Type of impact	Baseline Scenario		Introduce OEL=0.05mg/m ³		Introduce OEL=0.1mg/m ³		Introduce OEL=0.2mg/m ³	
	Costs	Benefits	Costs	Benefits	Costs	Benefits	Costs	Benefits
Social	Under the baseline there is estimated to be a greater number of firms installing and using closed systems and using RPE, PPE and wet cleaning rather than dry cleaning. These should not affect the skills required by workers and training costs are expected to be small.	Since the control measures such as closed system reduce risks of human exposure in a way that should not inhibit production, there should also be improvements in working conditions. The use of wet cleaning and RPE should also reduce risks of human exposure, although their use may potentially slow down operations or be perceived to do so.	Introducing an EU wide OEL of 0.05 is likely to have a much more significant impact on SMEs and there is a genuine risk that the costs of compliance could lead to firms closing down if the costs can not be passed through to consumer prices.	.	Introducing an EU wide OEL of 0.1mg/m ³ is likely to have a much more significant impact on SMEs and there is a genuine risk that the costs of compliance could lead to firms closing down if the costs can not be passed through to consumer prices.		There are not expected to be significant change relative to the baseline scenario, although there is a possible risk that the costs of compliance could lead to SMEs closing down if the costs can not be passed through to consumer prices	

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 impact	Baseline Scenario		Introduce OEL=0.05mg/m ³		Introduce OEL=0.1mg/m ³		Introduce OEL=0.2mg/m ³	
	Costs	Benefits	Costs	Benefits	Costs	Benefits	Costs	Benefits
Macro-economic	There are not expected to be any noticeable macroeconomic impacts under the baseline scenario.		Given the costs of compliance of around €34bn pounds over the period 2010-2070 there could possibly be a small macroeconomic impact over time. However this should be compared to the total value of goods and services in the manufacturing sector along which was €5trillion in 2006.		Short term spending on risk management measures may be good for the economy as equipment manufacturers (e.g. ventilation systems, booths, bag balers), 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 R&D, meaning the wider economy would not benefit from increased spending). With fewer life years lost and cancer registrations, there should be a benefit to the economy 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 greater consumption due to fewer premature deaths and greater taxes raised. However this is not expected to have a significant macroeconomic impact given the costs of compliance (€8-13bn) are small compared to the total value of goods and services in the manufacturing sector along which was €5trillion in 2006.			
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

Type of impact	Baseline Scenario		Introduce OEL=0.05mg/m ³		Introduce OEL=0.1mg/m ³		Introduce OEL=0.2mg/m ³	
	Costs	Benefits	Costs	Benefits	Costs	Benefits	Costs	Benefits
Environmental	Very little information is available regarding the ecotoxicity of respirable crystalline silica. No significant environmental effects are expected due to the chemical inertness and slow solubility of the substance. Crystalline silica is resistant to decomposition by weathering, biological activity and further oxidation.		The achievement of the OEL via the measures described in this report may lead to more direct emissions of respirable crystalline silica to the environment (through ventilation), but probably not to an increased overall environmental burden and therefore would not increase the level of environmental harm. Having said this, a quantitative assessment of the amounts of respirable crystalline silica releases into the environment as a result of the measures that would be put in place to achieve the OEL has not been done for the purposes of this study. The increased used of LEV may lead to additional demand for electricity. This, in turn, may result in additional GHG emissions. A quantitative assessment of the additional energy use has not been undertaken for the purposes of this study.					
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 RCS occurs in many industries, affecting a large number of workers. We estimate that approximately 5 300 000 employees in the EU were potentially exposed to RCS in 2006. Over 4 million of these workers are in the construction industry.

The estimated overall weighted geometric mean exposure across all countries and industries is 0.07 mg/m^3 with a GSD of 5.2. The sectors with the highest estimated mean exposure (0.09 mg/m^3) are construction and the utilities. The percentages of workers currently exposed to concentrations greater than 0.05, 0.1 and 0.2 mg/m^3 in the construction sector are estimated as 63, 48 and 32% respectively. Mean exposure concentrations in most other sectors are less than 0.03 mg/m^3 with the exception of non metallic mineral products (0.045 mg/m^3). The findings of an earlier IOM study indicate that exposure concentrations have fallen by about 7% per year over the past 20 – 30 years.

We estimate that in 2010 in the EU there will be about 6870 deaths from lung cancer and about 7645 cancer registrations that might be attributable to past exposure to RCS. This corresponds to about 2.45% of all lung cancer deaths amongst the exposed workers. If no specific actions are taken to reduce exposure to RCS, based on the assumption that current trends in employment and exposure are maintained until 2030 and remain steady thereafter, the predicted numbers of lung cancer deaths in 2060 attributable to RCS would be 5,685 with a predicted 72,091 years loss of life expectancy (YLLs) or 73,394 DALYS and 5,824 registrations.

The introduction of an OEL of 0.05 mg/m^3 would lead to reductions in the number of predicted lung cancer deaths and registrations in 2060 to 337 and 345 respectively corresponding to 4,151 YLLs or 4,347 DALYS. The introduction of an OEL of 0.1 mg/m^3 would lead to reductions in the number of predicted lung cancer deaths and registrations in 2060 to 818 and 838 respectively corresponding to 10,089 YLLs or 10,565 DALYS. The introduction of an OEL of 0.2 mg/m^3 would lead to reductions in the number of predicted lung cancer deaths and registrations in 2060 to 1,721 and 1,763 respectively corresponding to 21,217 YLLs or 22,217 DALYS. The number of “avoided” cancers associated with the introduction of an OEL of 0.05, 0.1 or 0.2 mg/m^3 would be 5,479, 4,985 and 4,061 respectively.

The total net health benefits accrued by 2070 from setting an OEL at 0.05 mg/m^3 are estimated to be between €27, 858m and €74,096. The benefits associated with an OEL of 0.1 mg/m^3 are estimated to be between €25,522m and €67,921m and the benefits associated with an OEL of 0.2 mg/m^3 are estimated to be between €21,171m and €56,393m. As most of the benefits are not realised until after 2040, the level of discounting has a substantial impact on estimated benefits. The biggest benefits arise in the construction sector.

The estimated costs of compliance are thought to be lower or within the range of the estimated benefits, indicating that the benefits of introducing an OEL may outweigh the costs of compliance. The total costs of compliance over the period 2010-2069 with an OEL of 0.05 mg/m^3 are estimated to be €34bn over the period 2010-2069. The greatest costs are predicted to fall on the construction sector (€17bn) given the the number of enterprises thought to be affected (around 485,000). The compliance costs for an OEL of 0.1 mg/m^3 are estimated to be substantially lower at €19bn over the same period. The greatest costs, €13 bn, would fall on the construction sector because of the large

number of affected enterprises (around 370,000). The estimated costs of compliance with an OEL of 0.2 mg/m³ are estimated to be €10bn with €8n falling on the construction sector (around 250,000 enterprises affected).

The majority of the companies that would be affected by the imposition of an OEL are small and the costs of meeting an OEL of 0.05 or 0.1 mg/m³ may be very expensive for a large proportion of the affected sectors. This may lead to some company closures and, for industries for which relocation is possible, some relocation of activities to outside of the EU. The imposition of an OEL of 0.2 mg/m³ would not be expected to have such a significant adverse impact on small businesses.

No significant environmental impacts would be anticipated following any increase in emissions of silica to ambient air as a result of improved workplace controls. The increased use of local exhaust ventilation (LEV), however, in order to achieve an OEL could lead to increased fossil fuel consumption and greenhouse emissions.

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8 APPENDIX

8.1 ESTIMATED NUMBER OF EMPLOYEES IN EACH INDUSTRY GROUP – MEMBER STATE BREAKDOWN – MALES AND FEMALES

Table 8.1.1 Number of workers exposed to RCS by Member State and NACE code – males and females

	NACE CODE														
	A			5			10			11			13		
	Agriculture, hunting and forestry			Fishing, Fish farming and related service activities			Mining of coal and lignite; extraction of peat			Extraction of crude petroleum and natural gas			Mining of metal ores		
	Employees			Employees			Employees			Employees			Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Austria	737	398	339	Not Available ^[1]			44	43	1	Not Available			Not Available		
Belgium	282	197	85	842	572	269	Not Available			Not Available			Not Available		
Bulgaria	852	554	298	Not Available			5408	4651	757	5	4	1	3894	3349	545
Cyprus	50	37	12	217	217	0	0	0	0	0	0	0	0	0	0
Czech Republic	606	424	182	Not Available			11544	10736	808	Not Available			17	16	1
Denmark	283	218	65	22	21	1	Not Available			Not Available			0	0	0
Estonia	102	69	33	Not Available			Not Available			Not Available			0	0	0
Finland	505	364	141	0	0	0	94	90	4	0	0	0	144	138	6
France	3106	2174	932	328	328	0	1240	955	285	21	16	5	208	160	48
Germany	2850	2023	826	Not Available			16187	14568	1619	57	51	6	0	0	0
Greece	1764	1023	741	19	16	3	Not Available			Not Available			435	422	13
Hungary	631	498	132	Not Available			101	96	5	10	9	0	165	157	8
Ireland	388	310	78	Not Available			Not Available			Not Available			Not Available		
Italy	0	0	0	0	0	0	0	0	0	370	341	30	Not Available		
Latvia	405	255	150	4	4	0	714	564	150	0	0	0	0	0	0
Lithuania	625	394	231	Not Available			474	403	71	4	4	1	0	0	0
Luxembourg	12	9	3	Not Available			0	0	0	0	0	0	0	0	0
Malta	9	6	3	Not Available			Not Available			Not Available			Not Available		
Netherlands	877	614	263	Not Available			15	13	2	51	44	7	0	0	0

NACE CODE															
	A			5			10			11			13		
	Agriculture, hunting and forestry			Fishing, Fish farming and related service activities			Mining of coal and lignite; extraction of peat			Extraction of crude petroleum and natural gas			Mining of metal ores		
	Employees			Employees			Employees			Employees			Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Poland	7798	4445	3353	Not Available			50074	46068	4006	23	21	2	Not Available		
Portugal	1998	999	999	65			0	0	0	0	0	0	634	615	19
Romania	9657	5022	4635	104	87	17	7589	6678	911	633	557	76	5247	4618	630
Slovakia	342	263	79	Not Available			Not Available			Not Available			Not Available		
Slovenia	311	165	146	Not Available			Not Available			Not Available			Not Available		
Spain	5001	3550	1450	280	221	59	8921	8297	624	0	0	0	207	193	15
Sweden	326	264	62	Not Available			245	218	27	0	0	0	3172	2823	349
UK	1274	1019	255	Not Available			2215	1883	332	285	242	43	0	0	0
TOTAL	40791	25297	15494	1879	1466	349	104865	95263	9603	1458	1289	170	14124	12490	1633

NACE CODE												
	14			15			17			18		
	Other mining and quarrying			Manufacture of food products, beverages and tobacco			Manufacture of textiles			Manufacture of wearing apparel; dressing and dyeing of fur		
	Employees			Employees			Employees			Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Austria	1745	1693	52	56	45	11	27	22	5	20	16	4
Belgium	Not Available			71	58	14	57	46	11	19	15	4
Bulgaria	2708	2329	379	81	42	39	63	33	30	348	181	167
Cyprus	214	214	0	9	7	2	1	1	0	3	2	1
Czech Republic	2382	2215	167	Not Available			85	55	30	84	54	29
Denmark	472	373	99	Not Available			11	8	3	6	4	2
Estonia	314	292	22	13	7	6	17	9	8	27	15	12
Finland	529	508	21	0	0	0	0	0	0	0	0	0

	NACE CODE											
	14			15			17			18		
	Other mining and quarrying			Manufacture of food products, beverages and tobacco			Manufacture of textiles			Manufacture of wearing apparel; dressing and dyeing of fur		
	Employees			Employees			Employees			Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
France	10308	7937	2371		Not Available		141	109	32	168	129	39
Germany	12872	11585	1287	608	474	134	187	146	41	136	106	30
Greece	2239	2172	67	63	48	15	34	26	8	93	71	22
Hungary	1623	1542	81	90	57	33	36	23	13	96	61	36
Ireland	1325	1272	53		Not Available		6	4	1	4	3	1
Italy		Not Available		0	0	0	0	0	0	0	0	0
Latvia	290	229	61	0	0	0	0	0	0	0	0	0
Lithuania	600	510	90	38	20	18	33	17	16	80	42	39
Luxembourg	121	121	0		Not Available		0	0	0	0	0	0
Malta	Not Available				Not Available			Not Available			Not Available	
Netherlands	788	678	110	94	78	16	26	21	4	10	9	2
Poland		Not Available		331	222	109	154	103	51	382	256	126
Portugal	5064	4912	152	79	47	32	139	82	57	277	164	114
Romania	4045	3560	485	152	82	70	131	71	60	641	346	295
Slovakia		Not Available			Not Available		27	17	10	60	39	22
Slovenia		Not Available		14	10	5	18	12	6	26	17	9
Spain	9294	8643	651	0	0	0	0	0	0	0	0	0
Sweden	969	862	107		Not Available		13	10	3	4	3	1
UK	11013	9361	1652	326	264	62	143	116	27	94	76	18
TOTAL	68916	61009	7908	2028	1461	567	1349	932	417	2578	1608	970

NACE CODE												
	19			21			22			23		
	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear			Manufacture of pulp, paper and paper products; publishing and printing			Publishing, printing and reproduction of recorded media			Manufacture of coke, refined petroleum products and nuclear fuel		
	Employees			Employees			Employees			Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Austria	24	19	5	104	84	20	54	44	10		Not Available	
Belgium	9	7	2	84	68	16	73	59	14	16	13	3
Bulgaria	106	55	51	65	34	31	36	19	17	13	7	6
Cyprus	1	1	0	5	3	1	5	4	1		Not Available	
Czech Republic	56	36	20	118	77	41	94	61	33	8	5	3
Denmark		Not Available		44	32	12	77	56	21		Not Available	
Estonia	8	5	4	11	6	5	14	8	6	3	2	1
Finland	0	0	0	299	221	78	0	0	0	0	0	0
France	152	117	35	463	356	106	400	308	92	74	57	17
Germany	99	78	22	847	661	186	771	601	170	56	44	12
Greece	29	22	7	44	34	11	60	46	14	11	8	3
Hungary	68	43	25	102	64	38	73	46	27	17	11	6
Ireland	1	1	0	20	15	5	33	25	8		Not Available	
Italy	0	0	0	0	0	0	0	0	0	0	0	0
Latvia	0	0	0	10	6	4	0	0	0	0	0	0
Lithuania	9	5	4	13	7	6	26	13	12		Not Available	
Luxembourg	0	0	0		Not Available			Not Available		0	0	0
Malta		Not Available			Not Available			Not Available			Not Available	
Netherlands	0	0	0	128	106	22	171	142	29	18	15	3
Poland	184	123	61	261	175	86	206	138	68	40	27	13
Portugal		Not Available		71	42	29	77	46	32		Not Available	
Romania	476	257	219	96	52	44	79	42	36	19	10	9
Slovakia		Not Available		45	29	16	24	15	9		Not Available	

NACE CODE												
	19 Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear Employees			21 Manufacture of pulp, paper and paper products; publishing and printing Employees			22 Publishing, printing and reproduction of recorded media Employees			23 Manufacture of coke, refined petroleum products and nuclear fuel Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Slovenia	28	19	10	31	21	11	21	14	7	0	0	0
Spain	0	0	0	453	353	100	0	0	0	71	55	16
Sweden	7	5	1	242	189	53	106	83	23	9	7	2
UK	55	45	11	434	351	82	698	566	133	65	52	12
TOTAL	1311	836	475	3989	2985	1003	3097	2334	763	418	312	106

NACE CODE												
	24 Manufacture of chemicals and chemical products Employees			25 Manufacture of rubber and plastic products Employees			26 Manufacture of other non-metallic mineral products Employees			27 Manufacture of basic metals Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Austria	24	19	5	177	143	34	11848	9597	2251	1963	1590	373
Belgium	62	50	12	170	138	32	10798	8746	2052	2003	1622	381
Bulgaria	23	12	11	150	78	72	9824	5108	4716	1331	692	639
Cyprus	2	1	0	7	6	2	1130	847	282	22	16	5
Czech Republic	37	24	13	534	347	187	25735	16728	9007	3405	2213	1192
Denmark	27	19	7	131	95	35	6061	4424	1636	318	232	86
Estonia	3	1	1	33	18	15	1921	1057	865	25	13	11
Finland	0	0	0	63	46	16	5186	3838	1348	995	736	259
France	244	188	56	1456	1121	335	46335	35678	10657	5919	4558	1361
Germany	407	317	90	2386	1861	525	80937	63131	17806	15254	11898	3356

	NACE CODE											
	24			25			26			27		
	Manufacture of chemicals and chemical products Employees			Manufacture of rubber and plastic products Employees			Manufacture of other non-metallic mineral products Employees			Manufacture of basic metals Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Greece	16	12	4	74	56	18	8571	6514	2057	814	619	195
Hungary	28	18	11	259	163	96	9598	6047	3551	1136	716	420
Ireland	22	17	6	63	47	16	3659	2745	915	145	109	36
Italy	0	0	0	2050	1538	513	78101	58576	19525	10583	7937	2646
Latvia	4	2	2	29	17	12	2122	1231	891	213	124	90
Lithuania	5	3	3	60	31	29	3997	2078	1918	55	28	26
Luxembourg	1	1	0	39	34	5	984	856	128	359	312	47
Malta	Not Available			Not Available			Not Available			Not Available		
Netherlands	57	47	10	206	171	35	9801	8135	1666	1240	1030	211
Poland	96	64	32	948	635	313	47255	31661	15594	4264	2857	1407
Portugal	19	11	8	163	96	67	20206	11921	8284	572	337	234
Romania	43	23	20	297	160	136	20216	10916	9299	3597	1942	1655
Slovakia	11	7	4	131	84	47	7028	4498	2530	1571	1005	565
Slovenia	12	8	4	86	57	29	3224	2128	1096	539	356	183
Spain	372	290	82	552	431	122	76141	59390	16751	3335	2601	734
Sweden	39	30	9	180	141	40	6800	5304	1496	2775	2164	610
UK	190	154	36	1311	1062	249	37721	30554	7167	4330	3507	823
TOTAL	1745	1322	423	11556	8577	2979	535200	391709	143491	66763	49217	17546

	NACE CODE											
	28			29			31			33		
	Manufacture of fabricated metal products, except machinery and equipment			Manufacture of machinery and equipment			Manufacture of electrical machinery and apparatus			Manufacture of medical, precision and optical instruments, watches and clocks		
	Employees			Employees			Employees			Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Austria	1097	889	208	1092	885	208	25	20	5	189	153	36
Belgium	1040	842	198	586	474	111	16	13	3	97	78	18
Bulgaria	638	332	306	941	489	452	20	10	9	80	42	39
Cyprus	58	44	15	14	10	3	0	0	0	2	2	1
Czech Republic	2556	1661	895	2188	1422	766	104	68	36	416	270	146
Denmark	726	530	196	840	613	227	22	16	6	205	149	55
Estonia	198	109	89	75	41	34	6	3	3	22	12	10
Finland	378	280	98	350	259	91	0	0	0	78	58	20
France	6571	5059	1511	4098	3156	943	136	104	31	1574	1212	362
Germany	12071	9415	2656	14156	11042	3114	467	364	103	3761	2933	827
Greece	616	468	148	305	232	73	7	5	2	25	19	6
Hungary	1141	719	422	920	580	340	62	39	23	231	146	86
Ireland	201	150	50	155	116	39	7	5	2	299	224	75
Italy	19673	14755	4918	14071	10554	3518	0	0	0	2369	1776	592
Latvia	149	86	63	97	56	41	3	2	1	21	12	9
Lithuania	282	146	135	146	76	70	6	3	3	46	24	22
Luxembourg	65	57	8	32	28	4		Not Available		26	22	4
Malta	Not Available			Not Available				Not Available		Not Available		
Netherlands	1507	1251	256	1200	996	204	16	13	3	301	250	51
Poland	4251	2848	1403	2779	1862	917	97	65	32	585	392	193
Portugal	1350	797	554	638	377	262	22	13	9	81	48	33
Romania	1573	849	723	1385	748	637	76	41	35	181	98	83
Slovakia	528	338	190	608	389	219	41	27	15	85	55	31
Slovenia	521	344	177	364	240	124	14	9	5	79	52	27

NACE CODE												
	28			29			31			33		
	Manufacture of fabricated metal products, except machinery and equipment			Manufacture of machinery and equipment			Manufacture of electrical machinery and apparatus			Manufacture of medical, precision and optical instruments, watches and clocks		
	Employees			Employees			Employees			Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Spain	3758	2931	827	1840	1435	405	245	191	54	364	284	80
Sweden	1302	1016	286	1572	1226	346	22	17	5	307	240	68
UK	5089	4122	967	3727	3019	708	112	91	21	1277	1034	243
TOTAL	67337	50038	17300	54179	40324	13854	1526	1121	405	12701	9586	3115

NACE CODE												
	35			36			40			41		
	Manufacture of other transport equipment			Manufacture of furniture; manufacturing			Electricity, gas, steam and hot water supply			Collection, purification and distribution of water		
	Employees			Employees			Employees			Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Austria	63	51	12	174	141	33	256	223	33	26	22	3
Belgium	53	43	10	94	76	18	148	129	19	59	51	8
Bulgaria	63	33	30	137	71	66	342	298	44	176	153	23
Cyprus	1	1	0	10	7	2	Not Available			Not Available		
Czech Republic	122	79	43	267	174	94	330	280	49	191	163	29
Denmark	44	32	12	103	75	28	123	98	25	32	25	6
Estonia	16	9	7	47	26	21	59	53	6	15	14	2
Finland	0	0	0	73	54	19	209	179	29	0	0	0
France	831	640	191	565	435	130	1424	1139	285	338	270	68
Germany	781	609	172	919	717	202	2089	1817	272	399	347	52
Greece	78	59	19	Not Available			Not Available			Not Available		
Hungary	45	29	17	123	78	46	293	246	47	204	171	33

NACE CODE												
	35 Manufacture of other transport equipment Employees			36 Manufacture of furniture; manufacturing Employees			40 Electricity, gas, steam and hot water supply Employees			41 Collection, purification and distribution of water Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Ireland	21	16	5	Not Available			Not Available			0	0	0
Italy	0	0	0	1294	971	324	0	0	0	0	0	0
Latvia	30	18	13	56	33	24	116	94	22	19	16	4
Lithuania	40	21	19	114	59	54	172	133	40	58	45	13
Luxembourg	Not Available			1	1	0	8	8	1	1	1	0
Malta	Not Available			Not Available			Not Available			Not Available		
Netherlands	141	117	24	146	121	25	171	137	34	47	37	9
Poland	398	267	131	818	548	270	1397	1187	210	455	387	68
Portugal	59	35	24	229	135	94	94	81	12	128	111	17
Romania	338	183	156	423	228	194	855	709	145	340	282	58
Slovakia	41	26	15	70	45	25	230	196	35	124	105	19
Slovenia	15	10	5	59	39	20	69	58	11	38	32	6
Spain	969	756	213	340	266	75	455	400	55	880	774	106
Sweden	125	97	27	188	147	41	259	208	52	10	8	2
UK	824	668	157	667	540	127	984	856	128	250	218	33
TOTAL	5100	3797	1303	6918	4986	1931	10082	8529	1553	3789	3233	556

NACE CODE												
	45 Construction Employees			60 Land transport, transport via pipelines Employees			61 Water transport Employees			62 Air transport Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Austria	72659	69026	3633	820	673	148	8	6	1	68	55	12
Belgium	75620	73351	2269	647	569	78	30	27	4	40	36	5

	NACE CODE											
	45			60			61			62		
	Construction			Land transport, transport via pipelines			Water transport			Air transport		
	Employees			Employees			Employees			Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Bulgaria	53305	50640	2665	637	580	57	96	87	9	18	16	2
Cyprus	9911	9514	396	32	25	7	85	66	19	16	13	4
Czech Republic	113120	105202	7918	1432	1189	243	Not Available			Not Available		
Denmark	58369	54867	3502	530	430	101	261	211	50	41	33	8
Estonia	14390	13095	1295	157	121	36	19	15	4	5	4	1
Finland	47026	44675	2351	465	377	88	0	0	0	0	0	0
France	475150	456144	19006	4967	4073	894	299	245	54	524	430	94
Germany	431193	418257	12936	4569	3838	731	585	491	94	402	338	64
Greece	89102	87320	1782	864	795	69	318	292	25	27	25	2
Hungary	69033	66962	2071	1110	988	122	22	19	2	19	17	2
Ireland	20855	20647	209	206	188	19	Not Available			Not Available		
Italy	112908	109520	3387	4136	3515	620	0	0	0	0	0	0
Latvia	21047	19574	1473	325	257	68	13	10	3	8	6	2
Lithuania	35917	33762	2155	443	364	80	31	25	6	6	5	1
Luxembourg	10279	10176	103	88	78	11	3	2	0	27	24	3
Malta	Not Available			Not Available			Not Available			Not Available		
Netherlands	138434	134281	4153	1332	1106	226	Not Available			Not Available		
Poland	201471	193413	8059	3334	2934	400	71	62	9	40	35	5
Portugal	142043	140623	1420	714	628	86	42	37	5	70	62	8
Romania	122965	113128	9837	1416	1246	170	69	61	8	26	22	3
Slovakia	20748	19918	830	420	361	59	13	12	2	6	5	1
Slovenia	20641	19609	1032	218	187	31	5	4	1	5	4	1
Spain	1277619	1226514	51105	3745	3258	487	0	0	0	0	0	0
Sweden	78119	74995	3125	925	777	148	270	227	43	54	45	9
UK	400900	392882	8018	3842	3342	499	280	244	36	653	568	85
TOTAL	4112824	3958093	154731	37376	31898	5478	2519	2144	374	2056	1745	312

NACE CODE												
	63			70			73			74		
	Services allied to transport			Real estate activities			Research and development			Other business activities		
	Employees			Employees			Employees			Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Austria	199	163	36	235	160	75	22	15	7	521	354	167
Belgium	178	157	21	166	111	55	26	17	9	733	491	242
Bulgaria	139	126	12	120	80	40	1	1	0	222	149	73
Cyprus	24	19	5	16	9	6	0	0	0	25	14	10
Czech Republic	147	122	25	290	174	116	26	15	10	637	382	255
Denmark	116	94	22	287	186	100	27	17	9	450	293	158
Estonia	39	30	9	71	40	31	2	1	1	74	41	32
Finland	0	0	0	260	153	106	13	8	5	0	0	0
France	955	783	172	1627	1074	553	176	116	60	4300	2838	1462
Germany	1775	1491	284	2179	1394	784	394	252	142	5848	3743	2105
Greece	144	132	11	30	17	12	37	22	15	496	293	204
Hungary	110	98	12	360	238	122	27	18	9	576	380	196
Ireland	70	64	6	122	82	40	10	7	3	253	170	84
Italy	0	0	0	0	0	0	0	0	0	0	0	0
Latvia	58	46	12	185	98	87	5	3	2	78	41	37
Lithuania	55	45	10	157	83	74	3	2	1	100	53	47
Luxembourg	9	8	1		Not Available			Not Available		71	44	27
Malta		Not Available			Not Available			Not Available			Not Available	
Netherlands	314	261	53	437	310	127	142	101	41	2230	1583	647
Poland	270	238	32	803	514	289	17	11	6	1203	770	433
Portugal	136	120	16	325	192	133	5	3	2	836	493	343
Romania	240	211	29	223	145	78	97	63	34	521	339	182
Slovakia	38	33	5	85	50	35	19	11	8	125	74	51
Slovenia	31	27	4	22	13	8	11	7	4	96	59	38
Spain	0	0	0	2192	1425	767	144	93	50	10397	6758	3639

NACE CODE												
	63			70			73			74		
	Services allied to transport			Real estate activities			Research and development			Other business activities		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Sweden	207	174	33	374	254	120	Not Available			633	430	203
UK	1318	1146	171	2589	1760	828	433	295	139	5795	3940	1854
TOTAL	6573	5588	985	13155	8566	4590	1638	1078	560	36219	23732	12487

NACE CODE												
	80			85			O			TOTAL		
	Education			Health and Social Work			Other community social and personal service activities			ALL INDUSTRIES		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Austria	108	31	77	10	2	7	1090	512	578	95486	87098	8388
Belgium	186	58	128	14	3	10	900	468	432	95118	88588	6529
Bulgaria	107	34	73	5	1	3	750	473	278	82703	70762	11941
Cyprus	11	3	8	0	0	0	102	46	56	11973	11132	841
Czech Republic	139	35	104	9	2	7	960	471	490	167639	144701	22938
Denmark	105	44	61	14	3	12	955	516	439	70698	63716	6982
Estonia	29	4	25	1	0	1	197	69	128	17910	15188	2723
Finland	100	33	67	36	4	32	194	78	116	56996	52098	4898
France	878	298	579	83	20	63	6439	2833	3606	581498	535063	46435
Germany	1028	206	822	114	22	93	11638	7681	3957	628021	572503	55519
Greece	149	55	94	6	2	4	764	344	420	107236	101170	6065
Hungary	157	39	118	8	2	6	963	452	510	89436	80769	8668
Ireland	64	17	47	6	1	5	585	293	293	28521	26527	1994
Italy	0	0	0	0	0	0	0	0	0	245555	209483	36073
Latvia	43	8	36	1	0	1	295	121	174	26342	22912	3430

	NACE CODE											
	80			85			O			TOTAL		
	Education			Health and Social Work			Other community social and personal service activities			ALL INDUSTRIES		
	Employees			Employees			Employees			Employees		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Lithuania	66	12	54	3	0	3	379	121	258	44043	38533	5509
Luxembourg	7	3	5	1	0	0	39	20	19	12173	11804	369
Malta	6	2	4	0	0	0	34.3	16	18	49	24	25
Netherlands	266	106	159	36	6	29	1730	761	969	161932	152540	9392
Poland	560	135	426	24	5	19	3138	1663	1475	333727	294130	39598
Portugal	154	42	112	9	2	8	857	368	488	177157	163438	13654
Romania	205	55	149	11	3	8	1426	856	570	185388	153690	31698
Slovakia	82	16	66	4	1	4	461	216	244	32969	27836	5133
Slovenia	37	8	29	2	0	1	232	130	102	26771	23639	3133
Spain	843	312	531	0	0	0	12092	5562	6530	1420510	1334985	85524
Sweden	240	60	180	21	4	17	1344	632	712	100861	92661	8200
UK	1253	363	890	99	21	78	8657	4415	4242	498904	468778	30126
TOTAL	6823	1980	4843	516	104	412	56220	29116	27103	5299619	4843767	455787

8.2 ESTIMATED DEATHS AND REGISTRATIONS IN THE EU FROM RESPIRABLE CRYSTALLINE SILICA EXPOSURE

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

Lung cancer deaths	Men						Women						
	FTY	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Austria		2,698	3,346	3,956	4,483	4,711	4,745	1,129	1,290	1,459	1,611	1,705	1,687
Belgium		0	0	0	0	0	0	0	0	0	0	0	0
Bulgaria		3,127	3,202	3,344	3,500	3,456	3,149	590	604	627	634	624	588
Cyprus		146	199	257	320	389	456	38	50	66	82	96	113
Cz Rep		4,741	5,771	6,660	7,492	8,086	8,078	1,582	1,790	2,024	2,204	2,278	2,323
Denmark		2,342	2,915	3,363	3,606	3,695	3,745	1,819	2,137	2,380	2,529	2,552	2,563
Estonia		610	666	751	847	937	982	154	166	172	182	189	183
Finland		1,686	2,167	2,617	2,783	2,822	2,923	592	693	786	824	818	817
France		24,854	29,288	33,628	36,549	38,217	39,689	6,697	7,502	8,353	9,042	9,293	9,389
Germany (including ex-GDR from 1991)		33,102	39,458	44,318	48,341	48,129	46,049	12,629	14,018	14,868	15,581	15,458	14,585
Greece		5,779	6,593	7,578	8,628	9,275	9,333	1,070	1,265	1,388	1,542	1,665	1,705
Hungary		6,068	6,634	7,398	8,125	8,599	8,624	2,437	2,557	2,746	2,803	2,814	2,785
Ireland		1,175	1,595	2,112	2,691	3,299	3,759	720	932	1,209	1,512	1,815	2,051
Italy		29,397	34,515	40,206	46,091	49,731	49,259	7,857	8,917	9,911	10,930	11,683	11,548
Latvia		1,025	1,091	1,220	1,355	1,483	1,502	220	231	239	256	265	264
Lithuania		1,384	1,538	1,764	1,982	2,138	2,164	267	286	313	344	352	350
Lux.		176	228	291	350	386	413	52	61	75	89	96	102
Malta		146	192	235	255	275	299	20	21	22	23	24	23
Netherlands		7,177	9,325	11,423	12,679	12,877	12,754	3,444	4,079	4,583	4,835	4,782	4,720
Poland		19,813	24,204	28,329	31,413	34,266	34,929	5,717	6,552	7,274	8,001	8,124	7,952
Portugal		3,111	3,600	4,173	4,708	5,070	5,188	677	778	878	977	1,046	1,073
Romania		8,342	9,179	10,368	11,480	11,726	11,057	1,935	2,100	2,335	2,521	2,626	2,589
Slovakia		1,963	2,488	3,057	3,508	3,884	3,932	438	508	608	709	742	773
Slovenia		944	1,168	1,406	1,545	1,581	1,552	282	317	353	379	379	370
Spain		20,051	24,629	30,491	36,512	40,400	40,734	2,942	3,503	4,051	4,536	4,903	5,021
Sweden		2,078	2,503	2,886	3,122	3,340	3,542	1,659	1,862	2,064	2,198	2,302	2,390
UK		21,915	26,107	30,805	34,784	38,234	41,219	15,291	17,180	19,778	22,297	24,098	25,562

Lung cancer deaths	Men						Women						
	FTY	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
European Union (27 countries)		210,064	249,072	289,493	323,680	342,919	348,763	70,053	79,186	88,770	96,845	100,598	100,564

Lung cancer registrations	Men						Women						
	FTY	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Ages 15+													
Austria		3,195	3,838	4,514	4,960	5,120	5,164	1,214	1,357	1,526	1,653	1,691	1,679
Belgium		7,322	8,692	10,013	10,852	11,262	11,628	1,292	1,445	1,593	1,703	1,753	1,779
Bulgaria		2,684	2,717	2,857	2,967	2,899	2,741	513	529	545	553	541	514
Cyprus		0	0	0	0	0	0	0	0	0	0	0	0
Cz Rep		5,691	6,740	7,663	8,472	8,896	8,764	1,447	1,647	1,808	1,937	2,003	1,988
Denmark		2,325	2,806	3,129	3,278	3,289	3,392	1,648	1,877	2,063	2,137	2,166	2,201
Estonia		630	684	762	847	921	949	142	148	156	161	163	163
Finland		1,681	2,142	2,375	2,420	2,462	2,527	609	716	780	795	789	788
France		26,745	31,101	34,491	36,630	37,854	39,219	5,039	5,699	6,221	6,585	6,689	6,754
Germany (including ex-GDR from 1991)		38,324	44,013	49,121	51,188	50,140	48,059	11,541	12,457	13,257	13,586	13,278	12,593
Greece		6,094	6,934	7,896	8,787	9,161	8,965	1,059	1,189	1,307	1,413	1,454	1,415
Hungary		6,802	7,380	8,170	8,966	9,417	9,471	2,371	2,499	2,628	2,710	2,719	2,683
Ireland		1,252	1,689	2,180	2,721	3,274	3,530	716	932	1,193	1,470	1,747	1,894
Italy		34,941	40,490	46,453	51,486	52,717	51,737	7,555	8,466	9,366	10,142	10,308	9,994
Latvia		951	1,015	1,110	1,226	1,296	1,278	181	183	191	198	200	196
Lithuania		1,385	1,524	1,745	1,956	2,094	2,138	226	238	261	277	279	278
Lux.		252	326	405	467	507	544	60	73	86	97	107	114
Malta		146	186	213	228	246	256	25	30	34	35	37	38
Netherlands		8,745	11,124	12,938	13,657	13,484	13,607	2,635	3,038	3,312	3,421	3,423	3,370
Poland		22,877	27,302	31,024	34,644	36,831	36,566	5,119	5,745	6,372	6,806	6,831	6,624
Portugal		2,875	3,318	3,829	4,280	4,552	4,608	628	711	793	859	897	892
Romania		7,766	8,440	9,584	10,539	10,779	10,354	1,701	1,842	2,018	2,197	2,264	2,208
Slovakia		2,512	3,125	3,739	4,299	4,667	4,649	456	534	616	676	706	697
Slovenia		988	1,219	1,418	1,534	1,555	1,485	284	317	347	361	357	341

Lung cancer registrations	Men						Women						
	FTY	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
Ages 15+													
Spain		21,064	25,941	31,814	36,979	39,486	38,712	2,341	2,769	3,238	3,632	3,854	3,807
Sweden		1,965	2,314	2,570	2,754	2,899	3,067	1,342	1,479	1,609	1,701	1,772	1,816
UK		27,363	32,395	37,148	40,910	43,779	47,708	16,430	18,564	21,109	23,352	24,834	26,443
European Union (27 countries)		234,922	275,404	314,082	343,072	356,383	358,425	66,807	75,248	83,431	89,518	91,591	90,888

8.3 SUPPLEMENTARY TABLES - COSTS UNDER THE BASELINE SCENARIO

Table 8.3.1 Health costs – baseline scenario – Member State breakdown - Based on a 4% discount rate

Low	Female	Male	Total	High	Female	Male	Total
Austria	€ 133	€ 2,810	€ 2,943	Austria	€ 273	€ 7,438	€ 7,711
Belgium	€ 5	€ 372	€ 377	Belgium	€ 169	€ 13,548	€ 13,718
Bulgaria	€ 93	€ 2,325	€ 2,418	Bulgaria	€ 175	€ 4,794	€ 4,969
Czech Republic	€ 397	€ 5,705	€ 6,102	Czech Republic	€ 801	€ 16,776	€ 17,577
Cyprus	€ 4	€ 187	€ 192	Cyprus	€ 0	€ 0	€ 0
Denmark	€ 264	€ 2,344	€ 2,608	Denmark	€ 507	€ 6,027	€ 6,534
Estonia	€ 30	€ 617	€ 648	Estonia	€ 66	€ 1,789	€ 1,855
Finland	€ 68	€ 1,590	€ 1,658	Finland	€ 149	€ 4,158	€ 4,307
France	€ 736	€ 26,565	€ 27,301	France	€ 931	€ 58,102	€ 59,034
Germany	€ 1,037	€ 19,287	€ 20,324	Germany	€ 1,852	€ 51,086	€ 52,938
Greece	€ 51	€ 4,932	€ 4,984	Greece	€ 117	€ 12,071	€ 12,187
Hungary	€ 223	€ 4,587	€ 4,810	Hungary	€ 427	€ 12,277	€ 12,705
Ireland	€ 32	€ 665	€ 697	Ireland	€ 67	€ 1,756	€ 1,823
Italy	€ 621	€ 9,267	€ 9,888	Italy	€ 1,222	€ 26,825	€ 28,046
Latvia	€ 27	€ 889	€ 916	Latvia	€ 56	€ 2,302	€ 2,358
Lithuania	€ 40	€ 1,530	€ 1,570	Lithuania	€ 85	€ 4,125	€ 4,210
Luxembourg	€ 5	€ 447	€ 452	Luxembourg	€ 11	€ 1,448	€ 1,459
Malta	€ 0	€ 0	€ 0	Malta	€ 0	€ 0	€ 0
Netherlands	€ 270	€ 6,283	€ 6,553	Netherlands	€ 384	€ 19,119	€ 19,503
Poland	€ 619	€ 13,145	€ 13,764	Poland	€ 1,080	€ 36,400	€ 37,480
Portugal	€ 97	€ 4,963	€ 5,060	Portugal	€ 181	€ 10,109	€ 10,290
Romania	€ 282	€ 5,473	€ 5,755	Romania	€ 541	€ 11,674	€ 12,214
Slovakia	€ 48	€ 998	€ 1,046	Slovakia	€ 110	€ 3,212	€ 3,322
Slovenia	€ 53	€ 1,104	€ 1,157	Slovenia	€ 105	€ 2,709	€ 2,814
Spain	€ 478	€ 48,582	€ 49,060	Spain	€ 667	€ 111,635	€ 112,301
Sweden	€ 158	€ 1,750	€ 1,907	Sweden	€ 257	€ 4,122	€ 4,379
United Kingdom	€ 979	€ 18,412	€ 19,392	United Kingdom	€ 2,285	€ 57,130	€ 59,415
TOTAL	€ 6,749	€ 184,831	€ 191,581	TOTAL	€ 12,516	€ 480,633	€ 493,148

Table 8.3.2 Health costs – baseline scenario – Industry group breakdown - Based on a 4% discount rate

Low	Female	Male	Total
Extraction of crude petroleum and natural gas	€ 1	€ 10	€ 11
Manufacture of coke, refined petroleum products and nuclear fuel	€ 2	€ 11	€ 13
Collection, purification and distribution of water	€ 2	€ 19	€ 21
Manufacture of pulp, paper and paper products; publishing and printing	€ 4	€ 18	€ 21
manufacture of chemicals and chemical products	€ 8	€ 44	€ 52
Manufacture of medical, precision and optical instruments, watches and clocks	€ 12	€ 61	€ 73
Publishing, printing and reproduction of recorded media	€ 16	€ 83	€ 99
Land transport, transport via pipelines	€ 12	€ 132	€ 144
Manufacture of other transport equipment	€ 25	€ 129	€ 155

Low	Female	Male	Total
Manufacture of furniture; manufacturing	€ 38	€ 173	€ 211
Electricity, gas, steam and hot water supply	€ 32	€ 290	€ 322
Mining of metal ores	€ 31	€ 415	€ 446
Mining of coal and lignite; extraction of peat	€ 44	€ 782	€ 826
Manufacture of machinery and equipment	€ 274	€ 1,390	€ 1,665
Manufacture of Basic Metals	€ 344	€ 1,683	€ 2,027
Manufacture of fabricated metal products, except machinery and equipment	€ 344	€ 1,739	€ 2,082
Other mining and quarrying	€ 134	€ 2,146	€ 2,280
Manufacture of other non-metallis mineral products	€ 2,767	€ 13,190	€ 15,956
Construction	€ 3,111	€ 168,375	€ 171,486
TOTAL	€ 17,258	€ 217,320	€ 199,942

High	Female	Male	Total
Extraction of crude petroleum and natural gas	€ 1	€ 25	€ 26
Manufacture of coke, refined petroleum products and nuclear fuel	€ 4	€ 28	€ 31
Manufacture of pulp, paper and paper products; publishing and printing	€ 7	€ 44	€ 51
Collection, purification and distribution of water	€ 4	€ 48	€ 52
manufacture of chemicals and chemical products	€ 15	€ 113	€ 128
Manufacture of medical, precision and optical instruments, watches and clocks	€ 22	€ 152	€ 174
Publishing, printing and reproduction of recorded media	€ 29	€ 214	€ 244
Land transport, transport via pipelines	€ 21	€ 331	€ 352
Manufacture of other transport equipment	€ 48	€ 333	€ 381
Manufacture of furniture; manufacturing	€ 72	€ 446	€ 517
Electricity, gas, steam and hot water supply	€ 60	€ 745	€ 805
Mining of metal ores	€ 58	€ 1,070	€ 1,128
Mining of coal and lignite; extraction of peat	€ 81	€ 1,965	€ 2,046
Manufacture of machinery and equipment	€ 518	€ 3,580	€ 4,098
Manufacture of Basic Metals	€ 649	€ 4,334	€ 4,983
Manufacture of fabricated metal products, except machinery and equipment	€ 649	€ 4,479	€ 5,127
Other mining and quarrying	€ 252	€ 5,524	€ 5,776
Manufacture of other non-metallis mineral products	€ 5,227	€ 34,002	€ 39,229
Construction	€ 5,882	€ 434,570	€ 440,453
TOTAL	€ 16,857	€ 563,470	€ 580,327

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

Table 8.3.3 Health costs – baseline scenario – Member State breakdown - Based on a declining discount rate

Low	Female	Male	Total	High	Female	Male	Total
Austria	€ 159	€ 3,391	€ 3,550	Austria	€ 329	€ 9,045	€ 9,374
Belgium	€ 6	€ 451	€ 456	Belgium	€ 203	€ 16,392	€ 16,595
Bulgaria	€ 110	€ 2,769	€ 2,880	Bulgaria	€ 210	€ 5,758	€ 5,969
Czech Republic	€ 476	€ 6,907	€ 7,383	Czech Republic	€ 970	€ 20,468	€ 21,438
Cyprus	€ 5	€ 228	€ 233	Cyprus	€ 0	€ 0	€ 0
Denmark	€ 314	€ 2,806	€ 3,120	Denmark	€ 607	€ 7,258	€ 7,865
Estonia	€ 36	€ 750	€ 786	Estonia	€ 79	€ 2,185	€ 2,264
Finland	€ 82	€ 1,940	€ 2,022	Finland	€ 181	€ 5,091	€ 5,272
France	€ 860	€ 31,202	€ 32,062	France	€ 1,095	€ 68,570	€ 69,664
Germany	€ 1,223	€ 22,984	€ 24,208	Germany	€ 2,203	€ 61,262	€ 63,465
Greece	€ 62	€ 5,985	€ 6,047	Greece	€ 141	€ 14,736	€ 14,878
Hungary	€ 266	€ 5,514	€ 5,780	Hungary	€ 512	€ 14,884	€ 15,396
Ireland	€ 39	€ 807	€ 846	Ireland	€ 82	€ 2,144	€ 2,226
Italy	€ 756	€ 11,366	€ 12,121	Italy	€ 1,496	€ 33,019	€ 34,515
Latvia	€ 32	€ 1,077	€ 1,110	Latvia	€ 67	€ 2,803	€ 2,870
Lithuania	€ 48	€ 1,865	€ 1,913	Lithuania	€ 103	€ 5,077	€ 5,180
Luxembourg	€ 6	€ 546	€ 552	Luxembourg	€ 13	€ 1,779	€ 1,793
Malta	€ 0	€ 0	€ 0	Malta	€ 0	€ 0	€ 0
Netherlands	€ 321	€ 7,574	€ 7,895	Netherlands	€ 460	€ 23,172	€ 23,632
Poland	€ 737	€ 15,852	€ 16,589	Poland	€ 1,298	€ 44,231	€ 45,529
Portugal	€ 117	€ 6,021	€ 6,138	Portugal	€ 220	€ 12,381	€ 12,601
Romania	€ 337	€ 6,569	€ 6,906	Romania	€ 654	€ 14,151	€ 14,805
Slovakia	€ 58	€ 1,216	€ 1,273	Slovakia	€ 134	€ 3,955	€ 4,089
Slovenia	€ 64	€ 1,340	€ 1,404	Slovenia	€ 127	€ 3,329	€ 3,456
Spain	€ 613	€ 63,234	€ 63,847	Spain	€ 868	€ 146,517	€ 147,385
Sweden	€ 187	€ 2,096	€ 2,283	Sweden	€ 307	€ 4,955	€ 5,262
United Kingdom	€ 1,120	€ 21,164	€ 22,284	United Kingdom	€ 2,624	€ 65,867	€ 68,491
TOTAL	€ 8,035	€ 225,655	€ 233,689	TOTAL	€ 14,984	€ 589,031	€ 604,014

Table 8.3.4 Health costs – baseline scenario – Industry group breakdown - Based on a declining discount rate

Low	Female	Male	Total
Extraction of crude petroleum and natural gas	€ 1	€ 10	€ 11
Manufacture of coke, refined petroleum products and nuclear fuel	€ 2	€ 13	€ 15
Manufacture of pulp, paper and paper products; publishing and printing	€ 4	€ 18	€ 22
Collection, purification and distribution of water	€ 2	€ 20	€ 22
manufacture of chemicals and chemical products	€ 10	€ 53	€ 63
Manufacture of medical, precision and optical instruments, watches and clocks	€ 12	€ 61	€ 74
Publishing, printing and reproduction of recorded media	€ 18	€ 99	€ 117
Land transport, transport via pipelines	€ 12	€ 135	€ 147
Manufacture of other transport equipment	€ 30	€ 156	€ 186
Manufacture of furniture; manufacturing	€ 45	€ 208	€ 253
Electricity, gas, steam and hot water supply	€ 38	€ 346	€ 384
Mining of metal ores	€ 36	€ 500	€ 537
Mining of coal and lignite; extraction of peat	€ 46	€ 820	€ 866
Manufacture of machinery and equipment	€ 328	€ 1,673	€ 2,001
Manufacture of Basic Metals	€ 411	€ 2,025	€ 2,436
Manufacture of fabricated metal products, except machinery and equipment	€ 412	€ 2,096	€ 2,508
Other mining and quarrying	€ 158	€ 2,576	€ 2,734
Manufacture of other non-metallis mineral products	€ 3,323	€ 15,963	€ 19,286
Construction	€ 3,749	€ 205,088	€ 208,837
TOTAL	€ 21,392	€ 271,350	€ 243,551

High	Female	Male	Total
Extraction of crude petroleum and natural gas	€ 1	€ 25	€ 27
Manufacture of coke, refined petroleum products and nuclear fuel	€ 5	€ 33	€ 38
Manufacture of pulp, paper and paper products; publishing and printing	€ 7	€ 45	€ 52
Collection, purification and distribution of water	€ 4	€ 49	€ 53
manufacture of chemicals and chemical products	€ 18	€ 137	€ 156
Manufacture of medical, precision and optical instruments, watches and clocks	€ 22	€ 153	€ 176
Publishing, printing and reproduction of recorded media	€ 35	€ 255	€ 290
Land transport, transport via pipelines	€ 22	€ 338	€ 360
Manufacture of other transport equipment	€ 57	€ 403	€ 460
Manufacture of furniture; manufacturing	€ 86	€ 539	€ 626
Electricity, gas, steam and hot water supply	€ 72	€ 897	€ 969
Mining of metal ores	€ 69	€ 1,297	€ 1,366
Mining of coal and lignite; extraction of peat	€ 85	€ 2,066	€ 2,150
Manufacture of machinery and equipment	€ 624	€ 4,336	€ 4,960
Manufacture of Basic Metals	€ 781	€ 5,247	€ 6,029
Manufacture of fabricated metal products, except machinery and equipment	€ 783	€ 5,434	€ 6,218
Other mining and quarrying	€ 300	€ 6,675	€ 6,975
Manufacture of other non-metallis mineral products	€ 6,328	€ 41,421	€ 47,749
Construction	€ 7,144	€ 532,867	€ 540,010
TOTAL	€ 21,081	€ 708,632	€ 729,713

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

Table 8.3.5 Summary

Costs by Gender (€m)	2010-2019	2020-2029	2030-2039	2040-2049	2050-2059	2060-2069
Female	1956 to 3524	1651 to 3000	1654 to 3086	1278 to 2442	890 to 1737	606 to 1195
Male	46122 to 117522	41864 to 107474	46495 to 120602	39531 to 104070	29926 to 80339	21718 to 59024
Total	48078 to 121046	43515 to 110474	48149 to 123688	40808 to 106512	30816 to 82076	22323 to 60219

Table 8.3.6 Health costs – baseline scenario – Member State breakdown - Based on a no discounting

Low	Female	Male	Total	High	Female	Male	Total
Austria	€ 378	€ 8,220	€ 8,598	Austria	€ 797	€ 22,311	€ 23,108
Belgium	€ 13	€ 1,098	€ 1,112	Belgium	€ 487	€ 39,956	€ 40,443
Bulgaria	€ 254	€ 6,475	€ 6,730	Bulgaria	€ 501	€ 13,785	€ 14,287
Czech Republic	€ 1,140	€ 16,857	€ 17,998	Czech Republic	€ 2,378	€ 50,983	€ 53,361
Cyprus	€ 13	€ 566	€ 579	Cyprus	€ 0	€ 0	€ 0
Denmark	€ 736	€ 6,672	€ 7,408	Denmark	€ 1,443	€ 17,483	€ 18,927
Estonia	€ 87	€ 1,845	€ 1,932	Estonia	€ 193	€ 5,464	€ 5,657
Finland	€ 199	€ 4,840	€ 5,039	Finland	€ 448	€ 12,805	€ 13,253
France	€ 1,922	€ 70,819	€ 72,741	France	€ 2,488	€ 157,414	€ 159,901
Germany	€ 2,800	€ 53,844	€ 56,644	Germany	€ 5,138	€ 145,638	€ 150,776
Greece	€ 150	€ 14,687	€ 14,837	Greece	€ 348	€ 36,749	€ 37,097
Hungary	€ 620	€ 13,216	€ 13,836	Hungary	€ 1,226	€ 36,510	€ 37,736
Ireland	€ 94	€ 1,980	€ 2,074	Ireland	€ 200	€ 5,344	€ 5,544
Italy	€ 1,879	€ 28,706	€ 30,585	Italy	€ 3,769	€ 84,153	€ 87,922
Latvia	€ 77	€ 2,638	€ 2,715	Latvia	€ 163	€ 6,947	€ 7,110
Lithuania	€ 117	€ 4,636	€ 4,753	Lithuania	€ 256	€ 12,932	€ 13,188
Luxembourg	€ 14	€ 1,365	€ 1,379	Luxembourg	€ 32	€ 4,514	€ 4,546
Malta	€ 0	€ 0	€ 0	Malta	€ 0	€ 0	€ 0
Netherlands	€ 750	€ 18,285	€ 19,035	Netherlands	€ 1,094	€ 56,607	€ 57,701
Poland	€ 1,729	€ 38,393	€ 40,122	Poland	€ 3,117	€ 109,222	€ 112,338
Portugal	€ 285	€ 14,810	€ 15,095	Portugal	€ 546	€ 31,193	€ 31,738
Romania	€ 794	€ 15,628	€ 16,422	Romania	€ 1,594	€ 34,623	€ 36,217
Slovakia	€ 139	€ 3,007	€ 3,147	Slovakia	€ 331	€ 10,058	€ 10,389
Slovenia	€ 153	€ 3,292	€ 3,445	Slovenia	€ 310	€ 8,417	€ 8,727
Spain	€ 1,717	€ 181,700	€ 183,417	Spain	€ 2,510	€ 429,304	€ 431,813
Sweden	€ 438	€ 4,990	€ 5,428	Sweden	€ 724	€ 11,912	€ 12,635
United Kingdom	€ 2,355	€ 45,062	€ 47,417	United Kingdom	€ 5,572	€ 141,345	€ 146,917
TOTAL	€ 18,856	€ 563,633	€ 582,489	TOTAL	€ 35,664	€ 1,485,668	€ 1,521,332

Table 8.3.7 Health costs – baseline scenario – Industry group breakdown - Based on a declining discount rate

Low	Female	Male	Total
Extraction of crude petroleum and natural gas	€ 1	€ 15	€ 16
Manufacture of pulp, paper and paper products; publishing and printing	€ 5	€ 26	€ 31
Collection, purification and distribution of water	€ 3	€ 29	€ 33
Manufacture of coke, refined petroleum products and nuclear fuel	€ 6	€ 31	€ 37
Manufacture of medical, precision and optical instruments, watches and clocks	€ 18	€ 88	€ 106
manufacture of chemicals and chemical products	€ 23	€ 129	€ 152
Land transport, transport via pipelines	€ 17	€ 200	€ 217
Publishing, printing and reproduction of recorded media	€ 42	€ 228	€ 270
Manufacture of other transport equipment	€ 71	€ 374	€ 445
Manufacture of furniture; manufacturing	€ 108	€ 500	€ 608
Electricity, gas, steam and hot water supply	€ 89	€ 821	€ 910
Mining of metal ores	€ 86	€ 1,206	€ 1,291
Mining of coal and lignite; extraction of peat	€ 73	€ 1,320	€ 1,393
Manufacture of machinery and equipment	€ 779	€ 4,028	€ 4,807
Manufacture of Basic Metals	€ 973	€ 4,871	€ 5,845
Manufacture of fabricated metal products, except machinery and equipment	€ 982	€ 5,073	€ 6,054
Other mining and quarrying	€ 363	€ 6,170	€ 6,534
Manufacture of other non-metallis mineral products	€ 7,976	€ 39,014	€ 46,990
Construction	€ 9,071	€ 509,537	€ 518,609
TOTAL	€ 56,033	€ 722,070	€ 605,873

High	Female	Male	Total
Extraction of crude petroleum and natural gas	€ 2	€ 38	€ 40
Manufacture of pulp, paper and paper products; publishing and printing	€ 10	€ 64	€ 74
Collection, purification and distribution of water	€ 6	€ 74	€ 80
Manufacture of coke, refined petroleum products and nuclear fuel	€ 11	€ 81	€ 92
Manufacture of medical, precision and optical instruments, watches and clocks	€ 33	€ 221	€ 254
manufacture of chemicals and chemical products	€ 45	€ 339	€ 384
Land transport, transport via pipelines	€ 32	€ 502	€ 534
Publishing, printing and reproduction of recorded media	€ 81	€ 599	€ 680
Manufacture of other transport equipment	€ 138	€ 983	€ 1,122
Manufacture of furniture; manufacturing	€ 209	€ 1,316	€ 1,525
Electricity, gas, steam and hot water supply	€ 171	€ 2,160	€ 2,332
Mining of metal ores	€ 166	€ 3,175	€ 3,341
Mining of coal and lignite; extraction of peat	€ 135	€ 3,341	€ 3,476
Manufacture of machinery and equipment	€ 1,510	€ 10,608	€ 12,118
Manufacture of Basic Metals	€ 1,886	€ 12,828	€ 14,714
Manufacture of fabricated metal products, except machinery and equipment	€ 1,904	€ 13,365	€ 15,269
Other mining and quarrying	€ 702	€ 16,242	€ 16,944
Manufacture of other non-metallis mineral products	€ 15,479	€ 102,873	€ 118,353
Construction	€ 17,619	€ 1,345,374	€ 1,362,993
TOTAL	€ 56,368	€ 1,917,297	€ 1,973,664

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

Table 8.3.8 Summary

Costs by Gender (€m)	2010-2019	2020-2029	2030-2039	2040-2049	2050-2059	2060-2069
Female	2380 to 4288	2973 to 5402	3464 to 6462	3595 to 6870	3367 to 6567	3078 to 6074
Male	56114 to 142983	75396 to 193554	97350 to 252514	111234 to 292839	113167 to 303810	110373 to 299968
Total	58494 to 147271	78368 to 198957	100813 to 258976	114829 to 299709	116534 to 310377	113451 to 306042

8.4 HEALTH BENEFITS – INTERVENTION SCENARIOS

Table 8.4.1: Proportions exposed above the exposure limits being tested by country, forecast scenario

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	1971-80	1981-90	1991-00	2001-10	2011-20	2021-30
OEL	0.05 mg/m ³						0.1 mg/m ³						0.2 mg/m ³					
Austria	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Belgium	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Bulgaria	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Cyprus	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Cz Rep	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Denmark	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Estonia	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Finland	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
France	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Germany	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Greece	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Hungary	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Ireland	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Italy	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Latvia	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Lithuania	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Lux.	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Malta	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Netherlands	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Poland	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Portugal	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Romania	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06

Forecast Scenario OEL	1971- 80 <i>0.05 mg/m³</i>	1981- 90	1991- 00	2001- 10	2011- 20	2021- 30	1971- 80 <i>0.1 mg/m³</i>	1981- 90	1991- 00	2001- 10	2011- 20	2021- 30	1971- 80 <i>0.2 mg/m³</i>	1981- 90	1991- 00	2001- 10	2011- 20	2021- 30
Slovakia	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Slovenia	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Spain	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
Sweden	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
UK	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06
zTOTAL	0.94	0.86	0.74	0.58	0.41	0.25	0.87	0.75	0.59	0.41	0.26	0.14	0.75	0.60	0.42	0.26	0.14	0.06

Table 8.4.2: Numbers and proportions of the population ever exposed for baseline and intervention^[1] scenarios (2) to (4), by country, men plus women

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m ³			
Country	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060
<i>Number ever exposed in the REP</i>										
Austria	411,490	422,480	435,218	436,869	438,013	438,666	435,218	436,869	438,013	438,666
Belgium	411,550	422,078	434,143	435,189	435,880	436,232	434,143	435,189	435,880	436,232
Bulgaria	357,412	366,405	376,759	377,383	377,784	377,972	376,759	377,383	377,784	377,972
Cyprus	52,469	53,680	55,035	54,998	54,960	54,920	55,035	54,998	54,960	54,920
Czech Republic	723,368	742,549	764,814	767,161	768,814	769,794	764,814	767,161	768,814	769,794
Denmark	309,366	318,193	328,537	330,553	331,985	332,850	328,537	330,553	331,985	332,850
Estonia	79,738	81,931	84,489	84,888	85,170	85,337	84,489	84,888	85,170	85,337
Finland	250,070	256,306	263,387	263,675	263,855	263,934	263,387	263,675	263,855	263,934
France	3,041,156	2,924,743	2,805,732	2,693,311	2,570,640	2,515,516	2,805,732	2,693,311	2,570,640	2,515,516
Germany	2,667,849	2,746,101	2,838,980	2,860,160	2,875,222	2,884,340	2,838,980	2,860,160	2,875,222	2,884,340
Greece	467,761	478,836	491,270	491,259	491,152	490,959	491,270	491,259	491,152	490,959
Hungary	388,356	399,090	411,615	413,696	415,158	416,021	411,615	413,696	415,158	416,021
Ireland	121,424	124,737	128,609	129,276	129,735	129,995	128,609	129,276	129,735	129,995
Italy	1,014,922	1,042,019	1,073,797	1,077,097	1,079,460	1,080,915	1,073,797	1,077,097	1,079,460	1,080,915
Latvia	116,723	119,716	123,162	123,513	123,743	123,857	123,162	123,513	123,743	123,857
Lithuania	196,070	200,921	206,443	206,715	206,877	206,934	206,443	206,715	206,877	206,934
Luxembourg	52,355	53,766	55,388	55,578	55,713	55,796	55,388	55,578	55,713	55,796
Malta	182	200	226	252	271	282	226	252	271	282
Netherlands	705,205	725,166	748,475	752,900	756,031	757,905	748,475	752,900	756,031	757,905
Poland	1,420,572	1,451,909	1,487,109	1,484,592	1,482,350	1,480,409	1,487,109	1,484,592	1,482,350	1,480,409
Portugal	774,960	793,540	814,446	814,398	814,249	814,011	814,446	814,398	814,249	814,011
Romania	830,549	842,149	853,376	843,432	835,736	830,271	853,376	843,432	835,736	830,271

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5			
Country	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060
<i>Number ever exposed in the REP</i>										
Slovakia	142,269	146,106	150,601	151,265	151,724	151,986	150,601	151,265	151,724	151,986
Slovenia	117,723	120,631	123,943	124,077	124,155	124,181	123,943	124,077	124,155	124,181
Spain	3,664,025	4,624,697	5,930,698	7,237,015	8,212,461	8,863,502	5,930,698	7,237,015	8,212,461	8,863,502
Sweden	433,232	445,792	460,581	463,698	465,920	467,272	460,581	463,698	465,920	467,272
United Kingdom	3,114,240	2,860,197	2,503,365	2,144,072	1,887,534	1,730,236	2,503,365	2,144,072	1,887,534	1,730,236
TOTAL	21,865,037	22,763,939	23,950,199	24,817,021	25,434,592	25,884,091	23,950,199	24,817,021	25,434,592	25,884,091

Scenario	Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Country	2030	2040	2050	2060	2030	2040	2050	2060
<i>Number ever exposed in the REP</i>								
Austria	435,218	436,869	438,013	438,666	435,218	436,869	438,013	438,666
Belgium	434,143	435,189	435,880	436,232	434,143	435,189	435,880	436,232
Bulgaria	376,759	377,383	377,784	377,972	376,759	377,383	377,784	377,972
Cyprus	55,035	54,998	54,960	54,920	55,035	54,998	54,960	54,920
Czech Republic	764,814	767,161	768,814	769,794	764,814	767,161	768,814	769,794
Denmark	328,537	330,553	331,985	332,850	328,537	330,553	331,985	332,850
Estonia	84,489	84,888	85,170	85,337	84,489	84,888	85,170	85,337
Finland	263,387	263,675	263,855	263,934	263,387	263,675	263,855	263,934
France	2,805,732	2,693,311	2,570,640	2,515,516	2,805,732	2,693,311	2,570,640	2,515,516
Germany	2,838,980	2,860,160	2,875,222	2,884,340	2,838,980	2,860,160	2,875,222	2,884,340
Greece	491,270	491,259	491,152	490,959	491,270	491,259	491,152	490,959
Hungary	411,615	413,696	415,158	416,021	411,615	413,696	415,158	416,021
Ireland	128,609	129,276	129,735	129,995	128,609	129,276	129,735	129,995

Scenario	Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Country	2030	2040	2050	2060	2030	2040	2050	2060
<i>Number ever exposed in the REP</i>								
Italy	1,073,797	1,077,097	1,079,460	1,080,915	1,073,797	1,077,097	1,079,460	1,080,915
Latvia	123,162	123,513	123,743	123,857	123,162	123,513	123,743	123,857
Lithuania	206,443	206,715	206,877	206,934	206,443	206,715	206,877	206,934
Luxembourg	55,388	55,578	55,713	55,796	55,388	55,578	55,713	55,796
Malta	226	252	271	282	226	252	271	282
Netherlands	748,475	752,900	756,031	757,905	748,475	752,900	756,031	757,905
Poland	1,487,109	1,484,592	1,482,350	1,480,409	1,487,109	1,484,592	1,482,350	1,480,409
Portugal	814,446	814,398	814,249	814,011	814,446	814,398	814,249	814,011
Romania	853,376	843,432	835,736	830,271	853,376	843,432	835,736	830,271
Slovakia	150,601	151,265	151,724	151,986	150,601	151,265	151,724	151,986
Slovenia	123,943	124,077	124,155	124,181	123,943	124,077	124,155	124,181
Spain	5,930,698	7,237,015	8,212,461	8,863,502	5,930,698	7,237,015	8,212,461	8,863,502
Sweden	460,581	463,698	465,920	467,272	460,581	463,698	465,920	467,272
United Kingdom	2,503,365	2,144,072	1,887,534	1,730,236	2,503,365	2,144,072	1,887,534	1,730,236
TOTAL	23,950,199	24,817,021	25,434,592	25,884,091	23,950,199	24,817,021	25,434,592	25,884,091

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Country	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
<i>Proportion of the population exposed</i>																		
Austria	6.72	6.47	6.41	6.30	6.29	6.37	6.41	6.30	6.29	6.37	6.41	6.30	6.29	6.37	6.41	6.30	6.29	6.37
Belgium	5.37	5.17	5.10	4.95	4.87	4.83	5.10	4.95	4.87	4.83	5.10	4.95	4.87	4.83	5.10	4.95	4.87	4.83
Bulgaria	6.37	6.66	7.26	7.60	8.09	8.75	7.26	7.60	8.09	8.75	7.26	7.60	8.09	8.75	7.26	7.60	8.09	8.75
Cyprus	9.39	7.91	7.16	6.44	5.91	5.58	7.16	6.44	5.91	5.58	7.16	6.44	5.91	5.58	7.16	6.44	5.91	5.58
Czech Republic	9.48	9.25	9.58	9.64	9.87	10.31	9.58	9.64	9.87	10.31	9.58	9.64	9.87	10.31	9.58	9.64	9.87	10.31
Denmark	8.05	7.92	7.88	7.84	7.83	7.76	7.88	7.84	7.83	7.76	7.88	7.84	7.83	7.76	7.88	7.84	7.83	7.76
Estonia	8.45	8.51	9.13	9.25	9.49	9.95	9.13	9.25	9.49	9.95	9.13	9.25	9.49	9.95	9.13	9.25	9.49	9.95
Finland	6.59	6.43	6.51	6.53	6.59	6.64	6.51	6.53	6.59	6.64	6.51	6.53	6.59	6.64	6.51	6.53	6.59	6.64
France	7.02	6.37	5.84	5.40	5.05	4.88	5.84	5.40	5.05	4.88	5.84	5.40	5.05	4.88	5.84	5.40	5.05	4.88
Germany	4.32	4.35	4.53	4.68	4.90	5.20	4.53	4.68	4.90	5.20	4.53	4.68	4.90	5.20	4.53	4.68	4.90	5.20
Greece	5.52	5.46	5.55	5.46	5.52	5.71	5.55	5.46	5.52	5.71	5.55	5.46	5.52	5.71	5.55	5.46	5.52	5.71
Hungary	5.33	5.38	5.63	5.73	5.88	6.12	5.63	5.73	5.88	6.12	5.63	5.73	5.88	6.12	5.63	5.73	5.88	6.12
Ireland	4.00	3.48	3.23	2.97	2.79	2.70	3.23	2.97	2.79	2.70	3.23	2.97	2.79	2.70	3.23	2.97	2.79	2.70
Italy	2.23	2.20	2.22	2.20	2.23	2.31	2.22	2.20	2.23	2.31	2.22	2.20	2.23	2.31	2.22	2.20	2.23	2.31
Latvia	7.24	7.36	8.04	8.33	8.72	9.38	8.04	8.33	8.72	9.38	8.04	8.33	8.72	9.38	8.04	8.33	8.72	9.38
Lithuania	8.41	8.32	8.83	9.16	9.57	10.31	8.83	9.16	9.57	10.31	8.83	9.16	9.57	10.31	8.83	9.16	9.57	10.31
Luxembourg	15.13	13.79	12.75	11.77	11.06	10.51	12.75	11.77	11.06	10.51	12.75	11.77	11.06	10.51	12.75	11.77	11.06	10.51
Malta	0.06	0.06	0.07	0.08	0.08	0.09	0.07	0.08	0.08	0.09	0.07	0.08	0.08	0.09	0.07	0.08	0.08	0.09
Netherlands	6.08	5.93	5.89	5.92	6.03	6.13	5.89	5.92	6.03	6.13	5.89	5.92	6.03	6.13	5.89	5.92	6.03	6.13
Poland	5.28	5.09	5.25	5.35	5.56	5.93	5.25	5.35	5.56	5.93	5.25	5.35	5.56	5.93	5.25	5.35	5.56	5.93
Portugal	9.82	9.54	9.43	9.19	9.16	9.31	9.43	9.19	9.16	9.31	9.43	9.19	9.16	9.31	9.43	9.19	9.16	9.31

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Country	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
<i>Proportion of the population exposed</i>																		
Romania	5.49	5.39	5.56	5.60	5.78	6.15	5.56	5.60	5.78	6.15	5.56	5.60	5.78	6.15	5.56	5.60	5.78	6.15
Slovakia	3.74	3.58	3.67	3.74	3.88	4.15	3.67	3.74	3.88	4.15	3.67	3.74	3.88	4.15	3.67	3.74	3.88	4.15
Slovenia	7.77	7.67	7.96	8.09	8.43	8.99	7.96	8.09	8.43	8.99	7.96	8.09	8.43	8.99	7.96	8.09	8.43	8.99
Spain	10.57	12.18	14.94	17.53	19.86	22.10	14.94	17.53	19.86	22.10	14.94	17.53	19.86	22.10	14.94	17.53	19.86	22.10
Sweden	6.63	6.29	6.30	6.16	6.01	5.92	6.30	6.16	6.01	5.92	6.30	6.16	6.01	5.92	6.30	6.16	6.01	5.92
United Kingdom	7.25	6.15	5.11	4.18	3.52	3.12	5.11	4.18	3.52	3.12	5.11	4.18	3.52	3.12	5.11	4.18	3.52	3.12
TOTAL	6.05	5.98	6.16	6.30	6.49	6.74	6.16	6.30	6.49	6.74	6.16	6.30	6.49	6.74	6.16	6.30	6.49	6.74

Table 8.4.3 Results for baseline and intervention^[1] scenarios for lung cancer, by country, men plus women

Scenario	All Scenarios						Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Country	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
Attributable Fraction																						
Austria	2.63	2.51	2.29	1.92	1.49	1.14	2.28	1.63	0.70	0.06	2.28	1.65	0.76	0.15	2.28	1.69	0.87	0.33				
Belgium	2.52	2.38	2.16	1.77	1.35	1.01	2.15	1.51	0.64	0.05	2.15	1.53	0.69	0.13	2.15	1.56	0.79	0.29				
Bulgaria	2.66	2.68	2.60	2.23	1.78	1.40	2.59	1.92	0.86	0.07	2.59	1.94	0.92	0.18	2.59	1.97	1.04	0.38				
Cyprus	3.98	3.31	2.76	2.12	1.52	1.09	2.75	1.80	0.72	0.06	2.75	1.82	0.78	0.15	2.75	1.86	0.89	0.32				
Czech Republic	3.59	3.43	3.22	2.72	2.17	1.71	3.20	2.33	1.04	0.11	3.20	2.36	1.13	0.25	3.21	2.41	1.30	0.52				
Denmark	2.54	2.47	2.26	1.88	1.44	1.06	2.25	1.61	0.68	0.05	2.25	1.62	0.74	0.13	2.25	1.66	0.84	0.29				
Estonia	3.71	3.61	3.53	3.00	2.38	1.87	3.52	2.56	1.12	0.10	3.52	2.59	1.21	0.24	3.52	2.65	1.39	0.53				
Finland	2.71	2.67	2.58	2.29	1.89	1.53	2.57	1.93	0.88	0.12	2.57	1.96	0.98	0.28	2.57	2.02	1.15	0.54				
France	3.25	2.86	2.37	1.85	1.33	0.94	2.36	1.59	0.63	0.05	2.36	1.60	0.68	0.12	2.36	1.64	0.78	0.26				
Germany	1.67	1.62	1.50	1.25	0.96	0.72	1.49	1.08	0.46	0.03	1.49	1.08	0.49	0.07	1.49	1.10	0.55	0.17				
Greece	2.58	2.49	2.35	1.99	1.59	1.26	2.34	1.69	0.74	0.07	2.34	1.71	0.81	0.18	2.34	1.75	0.94	0.38				
Hungary	2.17	2.14	2.02	1.73	1.36	1.04	2.01	1.47	0.64	0.05	2.01	1.49	0.69	0.13	2.02	1.52	0.79	0.28				
Ireland	1.36	1.16	0.97	0.73	0.51	0.36	0.96	0.62	0.24	0.01	0.97	0.63	0.26	0.04	0.97	0.64	0.29	0.09				
Italy	0.93	0.92	0.88	0.77	0.65	0.54	0.87	0.65	0.30	0.05	0.87	0.66	0.34	0.11	0.87	0.68	0.40	0.20				
Latvia	3.27	3.20	3.16	2.70	2.14	1.69	3.15	2.31	1.02	0.08	3.15	2.34	1.10	0.21	3.15	2.38	1.25	0.47				
Lithuania	3.87	3.74	3.64	3.18	2.58	2.09	3.62	2.72	1.22	0.12	3.62	2.75	1.33	0.29	3.62	2.81	1.52	0.61				
Luxembourg	6.43	5.94	5.24	4.32	3.36	2.55	5.21	3.66	1.58	0.19	5.22	3.71	1.75	0.44	5.22	3.81	2.04	0.88				
Malta	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				
Netherlands	2.29	2.22	2.05	1.74	1.36	1.02	2.04	1.48	0.64	0.05	2.04	1.50	0.69	0.12	2.04	1.53	0.79	0.28				
Poland	2.02	1.88	1.72	1.43	1.13	0.89	1.71	1.23	0.54	0.05	1.71	1.24	0.59	0.12	1.71	1.27	0.67	0.25				

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Country	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
<i>Attributable Fraction</i>																		
Portugal	4.44	4.27	3.95	3.36	2.71	2.16	3.93	2.85	1.27	0.15	3.93	2.89	1.40	0.35	3.94	2.96	1.63	0.71
Romania	2.08	1.99	1.87	1.58	1.23	0.96	1.86	1.35	0.59	0.05	1.86	1.37	0.64	0.12	1.87	1.39	0.72	0.27
Slovakia	1.57	1.47	1.36	1.14	0.90	0.70	1.35	0.97	0.43	0.03	1.35	0.98	0.46	0.08	1.35	1.00	0.52	0.19
Slovenia	3.13	3.06	2.96	2.58	2.12	1.73	2.94	2.19	1.00	0.10	2.94	2.22	1.09	0.24	2.94	2.27	1.25	0.52
Spain	4.19	4.72	5.57	5.86	5.67	5.28	5.53	4.75	2.41	0.37	5.53	4.84	2.71	0.88	5.54	5.00	3.24	1.79
Sweden	2.08	1.96	1.80	1.47	1.10	0.81	1.79	1.25	0.52	0.04	1.79	1.27	0.56	0.10	1.79	1.29	0.64	0.22
United Kingdom	2.65	2.23	1.69	1.12	0.67	0.39	1.68	1.00	0.36	0.01	1.69	1.01	0.38	0.04	1.69	1.02	0.41	0.09
TOTAL	2.45	2.35	2.21	1.92	1.57	1.27	2.20	1.62	0.72	0.07	2.20	1.64	0.79	0.18	2.20	1.68	0.91	0.38

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Country	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
Attributable Deaths																		
Austria	101	116	124	117	95	73	124	99	45	4	124	101	49	10	124	103	56	21
Belgium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bulgaria	99	102	103	92	73	52	103	79	35	3	103	80	37	7	103	82	43	14
Cyprus	7	8	9	9	7	6	9	7	3	0	9	7	4	1	9	7	4	2
Czech Republic	227	259	279	264	225	178	278	226	108	11	278	228	117	26	278	234	134	55
Denmark	106	125	130	115	90	67	129	99	43	3	129	100	46	8	129	102	52	18
Estonia	28	30	33	31	27	22	32	26	13	1	32	27	14	3	32	27	16	6
Finland	62	76	88	83	69	57	87	70	32	5	87	71	36	10	87	73	42	20
France	1,027	1,052	995	844	631	461	990	724	301	23	991	731	324	58	991	746	370	128
Germany	763	866	886	799	608	436	882	687	293	16	882	693	311	44	883	705	349	103
Greece	176	196	211	202	174	139	210	172	81	8	210	174	89	20	210	178	103	42
Hungary	184	196	205	189	155	119	204	161	73	6	204	163	79	15	204	166	90	32
Ireland	26	29	32	31	26	21	32	26	12	1	32	26	13	2	32	27	15	5
Italy	348	398	439	438	397	328	436	369	187	30	436	376	209	65	437	387	245	123
Latvia	41	42	46	44	37	30	46	37	18	1	46	38	19	4	46	38	22	8
Lithuania	64	68	76	74	64	53	75	63	30	3	75	64	33	7	75	65	38	15
Luxembourg	15	17	19	19	16	13	19	16	8	1	19	16	8	2	19	17	10	5
Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	243	298	327	304	240	179	326	260	113	8	326	262	122	22	326	268	139	49
Poland	517	577	612	564	477	380	610	484	230	21	610	489	248	51	610	499	282	108

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Country	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
Attributable Deaths																		
Portugal	168	187	200	191	166	135	199	162	78	9	199	164	85	22	199	168	99	44
Romania	213	225	238	221	177	131	237	189	85	7	237	191	91	17	237	195	104	37
Slovakia	38	44	50	48	42	33	50	41	20	1	50	41	21	4	50	42	24	9
Slovenia	38	45	52	50	42	33	52	42	20	2	52	43	21	5	52	44	25	10
Spain	963	1,327	1,926	2,406	2,570	2,415	1,910	1,952	1,094	171	1,911	1,988	1,227	404	1,913	2,053	1,467	820
Sweden	78	86	89	78	62	48	88	67	29	2	88	67	32	6	89	69	36	13
United Kingdom	985	966	855	639	415	264	852	570	224	10	852	574	235	27	853	581	258	63
TOTAL	6,870	7,715	8,373	8,087	6,952	5,685	8,327	6,822	3,194	337	8,330	6,911	3,489	818	8,336	7,077	4,043	1,721

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Country	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
Attributable Registrations																		
Austria	119	133	141	129	103	80	141	110	49	4	141	111	53	11	141	114	61	23
Belgium	217	241	251	223	176	136	250	190	83	7	250	192	90	18	250	196	103	39
Bulgaria	85	87	88	78	61	46	88	67	29	2	88	68	31	6	88	69	36	12
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Czech Republic	269	299	317	295	245	191	316	252	117	12	316	255	127	28	316	261	146	58
Denmark	104	119	120	104	80	60	119	89	38	3	119	90	41	7	119	92	47	16
Estonia	29	31	33	31	26	21	33	26	12	1	33	27	13	3	33	27	15	6
Finland	62	76	80	72	60	50	79	61	28	4	80	62	31	9	80	63	37	18
France	1,097	1,110	1,014	841	622	453	1,010	721	296	22	1,010	729	319	57	1,011	744	364	126
Germany	874	957	974	840	629	451	970	723	303	17	970	729	322	45	970	741	361	107
Greece	186	206	220	206	171	133	219	175	80	8	219	177	88	19	219	181	101	41
Hungary	206	217	226	207	169	130	224	177	80	6	225	179	86	16	225	183	98	35
Ireland	27	31	33	31	26	19	33	26	12	1	33	27	13	2	33	27	15	5
Italy	409	462	502	485	417	342	499	409	196	31	499	416	219	68	500	429	258	128
Latvia	38	39	42	39	33	25	42	34	16	1	42	34	17	3	42	35	19	7
Lithuania	64	67	74	73	63	52	74	62	30	3	74	63	32	7	74	64	37	15
Luxembourg	21	25	27	25	21	17	27	21	10	1	27	22	11	3	27	22	13	6
Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	293	351	367	325	249	189	365	277	118	9	365	280	127	23	365	286	145	51
Poland	591	645	666	617	509	395	663	529	245	22	663	535	265	53	663	546	301	113

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Country	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
<i>Attributable Registrations</i>																		
Portugal	156	172	183	174	149	120	182	147	70	8	182	149	77	19	182	153	89	39
Romania	198	206	219	202	162	122	218	173	78	6	218	175	84	16	218	179	95	34
Slovakia	48	55	61	58	50	39	60	50	24	2	60	50	25	5	60	51	29	10
Slovenia	40	47	52	49	41	32	52	42	19	2	52	42	21	4	52	43	24	9
Spain	1,010	1,395	2,005	2,433	2,508	2,291	1,989	1,974	1,068	162	1,990	2,010	1,198	383	1,993	2,076	1,432	778
Sweden	73	78	79	68	54	41	78	58	25	2	78	59	27	5	78	60	31	11
United Kingdom	1,222	1,192	1,026	748	474	304	1,023	668	255	11	1,023	672	268	31	1,023	681	295	73
TOTAL	7,645	8,493	9,047	8,540	7,200	5,824	8,998	7,204	3,307	345	9,001	7,297	3,613	838	9,007	7,473	4,187	1,763

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Country	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
Attributable Years of Life Lost (YLLs)																		
Austria	1,556	1,747	1,770	1,550	1,217	930	1,761	1,320	573	49	1,761	1,335	621	124	1,763	1,364	713	268
Belgium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bulgaria	1,438	1,462	1,452	1,248	921	638	1,445	1,071	443	32	1,445	1,082	475	80	1,446	1,103	540	174
Cyprus	108	117	120	111	95	75	119	95	45	4	119	96	48	10	119	98	56	22
Czech Republic	3,228	3,475	3,573	3,293	2,614	1,933	3,556	2,816	1,251	120	3,557	2,850	1,360	286	3,559	2,912	1,560	591
Denmark	1,443	1,603	1,558	1,324	1,008	759	1,551	1,131	478	36	1,551	1,142	514	93	1,552	1,166	586	207
Estonia	345	358	378	348	287	219	376	296	136	11	376	300	147	28	376	306	168	62
Finland	824	956	997	901	748	612	992	761	350	49	992	774	389	111	993	795	455	216
France	17,569	17,380	15,461	12,553	9,211	6,700	15,391	10,771	4,390	331	15,395	10,883	4,729	845	15,404	11,106	5,397	1,856
Germany	11,514	12,484	12,208	10,232	7,491	5,354	12,153	8,802	3,616	196	12,155	8,874	3,836	538	12,161	9,027	4,306	1,271
Greece	2,600	2,861	3,022	2,730	2,180	1,671	3,006	2,317	1,021	99	3,008	2,347	1,113	243	3,010	2,402	1,287	510
Hungary	2,694	2,780	2,846	2,521	1,944	1,425	2,832	2,152	921	67	2,833	2,174	990	174	2,834	2,219	1,129	386
Ireland	360	398	420	384	307	227	419	330	147	9	419	332	156	24	419	339	176	56
Italy	4,853	5,427	5,836	5,505	4,662	3,797	5,804	4,639	2,193	348	5,807	4,723	2,453	752	5,812	4,861	2,883	1,419
Latvia	496	510	541	494	407	302	538	423	194	15	538	427	209	38	539	436	238	83
Lithuania	814	866	925	868	720	551	920	741	341	31	920	749	370	76	921	766	425	162
Luxembourg	222	251	265	245	202	164	264	208	95	12	264	211	105	28	264	216	123	57
Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	3,388	3,911	3,944	3,432	2,626	1,981	3,924	2,928	1,241	93	3,926	2,958	1,335	242	3,928	3,020	1,524	539
Poland	7,498	8,025	7,998	7,197	5,821	4,276	7,961	6,175	2,805	235	7,963	6,241	3,025	574	7,968	6,367	3,442	1,220
Portugal	2,701	2,953	3,049	2,754	2,252	1,773	3,033	2,334	1,057	121	3,035	2,368	1,162	286	3,037	2,428	1,352	583

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Country	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
<i>Attributable Years of Life Lost (YLLs)</i>																		
Romania	3,253	3,400	3,516	3,111	2,305	1,627	3,499	2,666	1,105	85	3,500	2,694	1,190	211	3,502	2,749	1,354	454
Slovakia	521	583	622	575	465	341	619	491	221	15	619	496	237	40	619	506	269	90
Slovenia	597	668	713	636	502	383	709	541	237	22	709	548	257	54	710	560	296	114
Spain	15,398	21,422	30,257	35,057	34,258	30,731	30,011	28,437	14,581	2,172	30,030	28,963	16,360	5,136	30,064	29,915	19,559	10,430
Sweden	1,092	1,149	1,127	971	753	573	1,122	829	357	27	1,122	838	384	69	1,123	855	438	155
United Kingdom	13,346	12,700	10,733	7,724	4,918	3,098	10,701	6,894	2,649	116	10,703	6,937	2,780	317	10,706	7,029	3,059	742
TOTAL	103,403	112,744	116,896	107,070	88,004	70,091	116,260	90,327	40,433	4,151	116,304	91,496	44,165	10,089	116,386	93,699	51,178	21,217

Scenario	All Scenarios						Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Country	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060				
Attributable Years of Life Lived with Disability (DALYs)																						
Austria	1,627	1,827	1,852	1,624	1,276	975	1,843	1,383	601	52	1,843	1,398	651	130	1,845	1,429	748	281				
Belgium	129	141	144	127	100	77	143	108	47	4	143	109	51	10	143	111	58	22				
Bulgaria	1,493	1,517	1,508	1,297	958	666	1,501	1,113	460	33	1,501	1,124	494	83	1,502	1,146	561	182				
Cyprus	108	117	120	111	95	75	119	95	45	4	119	96	48	10	119	98	56	22				
Czech Republic	3,395	3,655	3,763	3,467	2,754	2,041	3,744	2,965	1,319	127	3,746	3,000	1,433	302	3,748	3,066	1,644	624				
Denmark	1,504	1,672	1,627	1,383	1,053	793	1,619	1,181	499	37	1,619	1,193	537	97	1,620	1,218	613	216				
Estonia	362	377	397	366	302	231	395	312	143	12	395	315	154	30	395	322	177	65				
Finland	860	998	1,042	941	782	639	1,036	795	366	51	1,036	808	406	116	1,037	830	476	226				
France	18,261	18,064	16,075	13,055	9,582	6,970	16,002	11,202	4,567	344	16,006	11,319	4,920	879	16,015	11,550	5,614	1,931				
Germany	12,031	13,049	12,767	10,707	7,847	5,608	12,710	9,211	3,787	205	12,713	9,286	4,017	564	12,719	9,446	4,510	1,331				
Greece	2,711	2,983	3,151	2,849	2,277	1,746	3,135	2,418	1,066	104	3,136	2,448	1,163	254	3,138	2,506	1,344	533				
Hungary	2,825	2,915	2,986	2,647	2,044	1,501	2,971	2,260	968	71	2,972	2,284	1,041	183	2,974	2,330	1,188	407				
Ireland	376	415	439	402	321	237	437	345	153	9	437	348	163	25	438	354	184	58				
Italy	5,092	5,696	6,125	5,778	4,895	3,988	6,091	4,869	2,303	365	6,094	4,957	2,576	790	6,099	5,102	3,027	1,490				
Latvia	519	534	566	518	426	317	564	443	203	16	564	448	219	40	564	457	249	87				
Lithuania	853	907	969	911	756	580	964	777	358	32	964	786	388	80	965	803	446	170				
Luxembourg	234	266	281	259	214	174	279	220	101	13	279	223	111	30	280	229	130	60				
Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
Netherlands	3,560	4,112	4,150	3,612	2,765	2,086	4,130	3,081	1,306	98	4,131	3,113	1,406	254	4,133	3,178	1,605	567				
Poland	7,871	8,418	8,396	7,565	6,117	4,500	8,357	6,491	2,947	247	8,359	6,561	3,178	604	8,364	6,693	3,617	1,284				
Portugal	2,796	3,058	3,159	2,856	2,338	1,842	3,143	2,421	1,097	126	3,144	2,456	1,206	297	3,146	2,518	1,403	605				

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Country	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
<i>Attributable Years of Life Lived with Disability (DALYs)</i>																		
Romania	3,381	3,533	3,656	3,237	2,403	1,700	3,639	2,775	1,152	89	3,640	2,804	1,241	220	3,642	2,860	1,412	475
Slovakia	551	617	658	610	493	363	655	521	234	16	655	526	251	43	655	537	286	96
Slovenia	622	696	743	664	525	401	740	565	247	23	740	572	269	56	740	585	309	120
Spain	16,009	22,266	31,454	36,467	35,675	32,028	31,198	29,581	15,184	2,264	31,218	30,128	17,037	5,352	31,254	31,118	20,369	10,870
Sweden	1,134	1,193	1,172	1,010	784	596	1,166	862	371	28	1,167	871	399	72	1,167	889	455	161
United Kingdom	14,044	13,373	11,306	8,139	5,181	3,266	11,272	7,264	2,790	122	11,274	7,310	2,929	334	11,278	7,406	3,223	783
TOTAL	108,005	117,793	122,187	111,991	92,112	73,394	121,523	94,477	42,320	4,347	121,568	95,701	46,227	10,565	121,654	98,005	53,566	22,217

[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 8.4.4 Numbers and proportions of the population ever exposed for baseline and intervention^[1] scenarios (2) to (4), by country, men plus women

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060
<i>Number ever exposed in the REP</i>										
Agriculture, hunting and forestry	259,198	220,776	166,538	112,299	71,164	42,935	166,538	112,299	71,164	42,935
Fishing, Fish farming and related service activities	10,741	9,146	6,897	4,648	2,945	1,778	6,897	4,648	2,945	1,778
Mining of coal and lignite; extraction of peat	364,260	375,783	390,170	394,995	398,591	401,134	390,170	394,995	398,591	401,134
Extraction of crude petroleum and natural gas	5,756	5,721	5,650	5,456	5,315	5,228	5,650	5,456	5,315	5,228
Mining of metal ores	50,828	52,110	53,658	53,771	53,843	53,901	53,658	53,771	53,843	53,901
Other mining and quarrying	259,455	260,669	262,089	259,608	257,343	256,570	262,089	259,608	257,343	256,570
Manufacture of food products, beverages and tobacco	8,597	8,607	8,582	8,356	8,193	8,091	8,582	8,356	8,193	8,091
Manufacture of textiles	5,780	5,790	5,789	5,662	5,561	5,503	5,789	5,662	5,561	5,503
Manufacture of wearing apparel; dressing and dyeing of fur	10,984	11,144	11,327	11,229	11,147	11,102	11,327	11,229	11,147	11,102
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	5,619	5,676	5,740	5,672	5,613	5,581	5,740	5,672	5,613	5,581
Manufacture of pulp, paper and paper products; publishing and printing	15,952	16,172	16,446	16,419	16,379	16,386	16,446	16,419	16,379	16,386
Publishing, printing and reproduction of recorded media	13,605	13,384	13,052	12,488	12,055	11,800	13,052	12,488	12,055	11,800
Manufacture of coke, refined petroleum products and nuclear fuel	1,691	1,708	1,730	1,728	1,723	1,725	1,730	1,728	1,723	1,725
Manufacture of chemicals and chemical products	6,701	6,869	7,094	7,214	7,293	7,363	7,094	7,214	7,293	7,363
Manufacture of rubber and plastic products	47,775	47,980	48,169	47,420	46,792	46,473	48,169	47,420	46,792	46,473
Manufacture of other non-metallic mineral products	2,083,015	2,136,855	2,206,091	2,232,222	2,249,780	2,264,911	2,206,091	2,232,222	2,249,780	2,264,911
Manufacture of Basic Metals	268,637	272,497	277,088	275,616	274,227	273,689	277,088	275,616	274,227	273,689
Manufacture of fabricated metal products, except machinery and	271,227	274,703	278,816	277,029	275,380	274,718	278,816	277,029	275,380	274,718

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Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060
<i>Number ever exposed in the REP</i>										
equipment										
Manufacture of machinery and equipment	218,468	221,239	224,399	222,495	220,884	220,092	224,399	222,495	220,884	220,092
Manufacture of electrical machinery and apparatus	5,902	6,065	6,277	6,370	6,434	6,487	6,277	6,370	6,434	6,487
Manufacture of medical, precision and optical instruments, watches and clocks	52,287	52,489	52,658	51,758	51,009	50,613	52,658	51,758	51,009	50,613
Manufacture of other transport equipment	20,477	20,726	21,057	21,103	21,103	21,166	21,057	21,103	21,103	21,166
Manufacture of furniture; manufacturing	28,413	28,705	29,026	28,727	28,481	28,359	29,026	28,727	28,481	28,359
Electricity, gas, steam and hot water supply	39,529	39,693	39,859	39,264	38,747	38,491	39,859	39,264	38,747	38,491
Collection, purification and distribution of water	13,344	13,861	14,550	14,993	15,310	15,548	14,550	14,993	15,310	15,548
Construction	17,316,890	18,077,639	19,080,987	19,843,786	20,391,939	20,794,953	19,080,987	19,843,786	20,391,939	20,794,953
Land transport, transport via pipelines	102,125	123,047	152,535	182,317	203,639	216,767	152,535	182,317	203,639	216,767
Water Transport	6,881	8,291	10,278	12,285	13,722	14,606	10,278	12,285	13,722	14,606
Air Transport	5,631	6,784	8,410	10,052	11,228	11,952	8,410	10,052	11,228	11,952
Services allied to transport	17,956	21,635	26,820	32,056	35,805	38,113	26,820	32,056	35,805	38,113
Real estate activities	39,342	47,373	58,728	70,229	78,488	83,591	58,728	70,229	78,488	83,591
Research and development	4,883	5,880	7,289	8,716	9,741	10,374	7,289	8,716	9,741	10,374
Other business activities	108,783	130,985	162,384	194,187	217,029	231,145	162,384	194,187	217,029	231,145
Education	22,476	27,047	33,533	40,118	44,861	47,802	33,533	40,118	44,861	47,802
Health and Social Work	1,743	2,097	2,600	3,111	3,479	3,708	2,600	3,111	3,479	3,708
Other community social and personal service activities	170,087	204,791	253,883	303,618	339,348	361,434	253,883	303,618	339,348	361,434

Scenario Industry sector	Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m ⁵				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m ⁵			
	2030	2040	2050	2060	2030	2040	2050	2060
Agriculture, hunting and forestry	166,538	112,299	71,164	42,935	166,538	112,299	71,164	42,935
Fishing, Fish farming and related service activities	6,897	4,648	2,945	1,778	6,897	4,648	2,945	1,778
Mining of coal and lignite; extraction of peat	390,170	394,995	398,591	401,134	390,170	394,995	398,591	401,134
Extraction of crude petroleum and natural gas	5,650	5,456	5,315	5,228	5,650	5,456	5,315	5,228
Mining of metal ores	53,658	53,771	53,843	53,901	53,658	53,771	53,843	53,901
Other mining and quarrying	262,089	259,608	257,343	256,570	262,089	259,608	257,343	256,570
Manufacture of food products, beverages and tobacco	8,582	8,356	8,193	8,091	8,582	8,356	8,193	8,091
Manufacture of textiles	5,789	5,662	5,561	5,503	5,789	5,662	5,561	5,503
Manufacture of wearing apparel; dressing and dyeing of fur	11,327	11,229	11,147	11,102	11,327	11,229	11,147	11,102
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	5,740	5,672	5,613	5,581	5,740	5,672	5,613	5,581
Manufacture of pulp, paper and paper products; publishing and printing	16,446	16,419	16,379	16,386	16,446	16,419	16,379	16,386
Publishing, printing and reproduction of recorded media	13,052	12,488	12,055	11,800	13,052	12,488	12,055	11,800
Manufacture of coke, refined petroleum products and nuclear fuel	1,730	1,728	1,723	1,725	1,730	1,728	1,723	1,725
Manufacture of chemicals and chemical products	7,094	7,214	7,293	7,363	7,094	7,214	7,293	7,363
Manufacture of rubber and plastic products	48,169	47,420	46,792	46,473	48,169	47,420	46,792	46,473
Manufacture of other non-metallis mineral products	2,206,091	2,232,222	2,249,780	2,264,911	2,206,091	2,232,222	2,249,780	2,264,911
Manufacture of Basic Metals	277,088	275,616	274,227	273,689	277,088	275,616	274,227	273,689
Manufacture of fabricated metal products, except machinery and equipment	278,816	277,029	275,380	274,718	278,816	277,029	275,380	274,718
Manufacture of machinery and equipment	224,399	222,495	220,884	220,092	224,399	222,495	220,884	220,092
Manufacture of electrical machinery and apparatus	6,277	6,370	6,434	6,487	6,277	6,370	6,434	6,487
Manufacture of medical, precision and optical instruments, watches and clocks	52,658	51,758	51,009	50,613	52,658	51,758	51,009	50,613
Manufacture of other transport equipment	21,057	21,103	21,103	21,166	21,057	21,103	21,103	21,166
Manufacture of furniture; manufacturing	29,026	28,727	28,481	28,359	29,026	28,727	28,481	28,359
Electricity, gas, steam and hot water supply	39,859	39,264	38,747	38,491	39,859	39,264	38,747	38,491

Scenario Industry sector	Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m ⁵				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m ⁵			
	2030	2040	2050	2060	2030	2040	2050	2060
Collection, purification and distribution of water	14,550	14,993	15,310	15,548	14,550	14,993	15,310	15,548
Construction	19,080,987	19,843,786	20,391,939	20,794,953	19,080,987	19,843,786	20,391,939	20,794,953
Land transport, transport via pipelines	152,535	182,317	203,639	216,767	152,535	182,317	203,639	216,767
Water Transport	10,278	12,285	13,722	14,606	10,278	12,285	13,722	14,606
Air Transport	8,410	10,052	11,228	11,952	8,410	10,052	11,228	11,952
Services allied to transport	26,820	32,056	35,805	38,113	26,820	32,056	35,805	38,113
Real estate activities	58,728	70,229	78,488	83,591	58,728	70,229	78,488	83,591
Research and development	7,289	8,716	9,741	10,374	7,289	8,716	9,741	10,374
Other business activities	162,384	194,187	217,029	231,145	162,384	194,187	217,029	231,145
Education	33,533	40,118	44,861	47,802	33,533	40,118	44,861	47,802
Health and Social Work	2,600	3,111	3,479	3,708	2,600	3,111	3,479	3,708
Other community social and personal service activities	253,883	303,618	339,348	361,434	253,883	303,618	339,348	361,434

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
	Proportion of the population exposed																	
Agriculture, hunting and forestry	0.072	0.058	0.043	0.029	0.018	0.011	0.043	0.029	0.018	0.011	0.043	0.029	0.018	0.011	0.043	0.029	0.018	0.011
Fishing, Fish farming and related service activities	0.003	0.002	0.002	0.001	0.001	0.000	0.002	0.001	0.001	0.000	0.002	0.001	0.001	0.000	0.002	0.001	0.001	0.000
Mining of coal and lignite; extraction of peat	0.101	0.099	0.100	0.100	0.102	0.104	0.100	0.100	0.102	0.104	0.100	0.100	0.102	0.104	0.100	0.100	0.102	0.104
Extraction of crude petroleum and natural gas	0.002	0.002	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
Mining of metal ores	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Other mining and quarrying	0.072	0.068	0.067	0.066	0.066	0.067	0.067	0.066	0.066	0.067	0.067	0.066	0.066	0.067	0.067	0.066	0.066	0.067
Manufacture of food products, beverages and tobacco	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
Manufacture of textiles	0.002	0.002	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
Manufacture of wearing apparel; dressing and dyeing of fur	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
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	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
Manufacture of pulp, paper and paper products; publishing and printing	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
Publishing, printing and reproduction of recorded media	0.004	0.004	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
Manufacture of coke, refined petroleum products and nuclear fuel	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
manufacture of chemicals and chemical products	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
Manfature of rubber and plastic products	0.013	0.013	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
Manufacture of other non-metallis mineral products	0.577	0.561	0.567	0.567	0.574	0.590	0.567	0.567	0.574	0.590	0.567	0.567	0.574	0.590	0.567	0.567	0.574	0.590
Manufacture of Basic Metals	0.074	0.072	0.071	0.070	0.070	0.071	0.071	0.070	0.070	0.071	0.071	0.070	0.070	0.071	0.071	0.070	0.070	0.071
Manufacture of fabricated metal products, except machinery and equipment	0.075	0.072	0.072	0.070	0.070	0.072	0.072	0.070	0.070	0.072	0.072	0.070	0.070	0.072	0.072	0.070	0.070	0.072
Manufacture of machinery and equipment	0.060	0.058	0.058	0.056	0.056	0.057	0.058	0.056	0.056	0.057	0.058	0.056	0.056	0.057	0.058	0.056	0.056	0.057

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
	<i>Proportion of the population exposed</i>																	
Manufacture of electrical machinery and apparatus	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
Manufacture of medical, precision and optical instruments, watches and clocks	0.014	0.014	0.014	0.013	0.013	0.013	0.014	0.013	0.013	0.013	0.014	0.013	0.013	0.013	0.014	0.013	0.013	0.013
Manufacture of other transport equipment	0.006	0.005	0.005	0.005	0.005	0.006	0.005	0.005	0.005	0.006	0.005	0.005	0.005	0.006	0.005	0.005	0.005	0.006
Manufacture of furniture; manufacturing	0.008	0.008	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
Electricity, gas, steam and hot water supply	0.011	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Collection, purification and distribution of water	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
Construction	4.793	4.748	4.907	5.038	5.202	5.415	4.907	5.038	5.202	5.415	4.907	5.038	5.202	5.415	4.907	5.038	5.202	5.415
Land transport, transport via pipelines	0.028	0.032	0.039	0.046	0.052	0.056	0.039	0.046	0.052	0.056	0.039	0.046	0.052	0.056	0.039	0.046	0.052	0.056
Water Transport	0.002	0.002	0.003	0.003	0.004	0.004	0.003	0.003	0.004	0.004	0.003	0.003	0.004	0.004	0.003	0.003	0.004	0.004
Air Transport	0.002	0.002	0.002	0.003	0.003	0.003	0.002	0.003	0.003	0.003	0.002	0.003	0.003	0.003	0.002	0.003	0.003	0.003
Services allied to transport	0.008	0.010	0.012	0.014	0.015	0.016	0.007	0.008	0.009	0.010	0.007	0.008	0.009	0.010	0.007	0.008	0.009	0.010
Real estate activities	0.011	0.012	0.015	0.018	0.020	0.022	0.015	0.018	0.020	0.022	0.015	0.018	0.020	0.022	0.015	0.018	0.020	0.022
Research and development	0.001	0.002	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.003
Other business activities	0.030	0.034	0.042	0.049	0.055	0.060	0.042	0.049	0.055	0.060	0.042	0.049	0.055	0.060	0.042	0.049	0.055	0.060
Education	0.006	0.007	0.009	0.010	0.011	0.012	0.009	0.010	0.011	0.012	0.009	0.010	0.011	0.012	0.009	0.010	0.011	0.012
Health and Social Work	0.000	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
Other community social and personal service activities	0.047	0.054	0.065	0.077	0.087	0.094	0.065	0.077	0.087	0.094	0.065	0.077	0.087	0.094	0.065	0.077	0.087	0.094

Table 8.4.5 Occupational attributable fractions, deaths, registrations, YLLs and DALYs for lung cancer by industry, men plus women

Scenario	All Scenarios						Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m ⁵				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m ⁵				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m ⁵			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
	<i>Attributable Fraction</i>																					
Agriculture, hunting and forestry	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	0.00	0.00	0.00	0.00
Fishing, Fish farming and related service activities	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	0.00	0.00	0.00	0.00
Mining of coal and lignite; extraction of peat	0.02	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Extraction of crude petroleum and natural gas	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	0.00	0.00	0.00	0.00
Mining of metal ores	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Other mining and quarrying	0.03	0.03	0.03	0.02	0.02	0.01	0.03	0.02	0.01	0.00	0.03	0.02	0.01	0.00	0.03	0.02	0.01	0.00	0.03	0.02	0.01	0.00
Manufacture of food products, beverages and tobacco	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	0.00	0.00	0.00	0.00
Manufacture of textiles	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	0.00	0.00	0.00	0.00
Manufacture of wearing apparel; dressing and dying of fur	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	0.00	0.00	0.00	0.00
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	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	0.00	0.00	0.00	0.00
Manufacture of pulp, paper and paper products; publishing and printing	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	0.00	0.00	0.00	0.00
Publishing, printing and reproduction of recorded media	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	0.00	0.00	0.00	0.00

Scenario	All Scenarios						Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
	<i>Attributable Fraction</i>																					
Manufacture of coke, refined petroleum products and nuclear fuel	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	0.00	0.00	0.00	0.00
Manufacture of chemicals and chemical products	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	0.00	0.00	0.00	0.00
Manufacture of rubber and plastic products	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	0.00	0.00	0.00	0.00
Manufacture of other non-metalliferous mineral products	0.20	0.19	0.18	0.15	0.12	0.09	0.17	0.13	0.06	0.01	0.17	0.13	0.06	0.01	0.17	0.13	0.07	0.03				
Manufacture of Basic Metals	0.03	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.00	0.02	0.02	0.01	0.00	0.02	0.02	0.01	0.00				
Manufacture of fabricated metal products, except machinery and equipment	0.03	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.01	0.00	0.02	0.02	0.01	0.00	0.02	0.02	0.01	0.00				
Manufacture of machinery and equipment	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.00	0.02	0.01	0.01	0.00	0.02	0.01	0.01	0.00				
Manufacture of electrical machinery and apparatus	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				
Manufacture of medical, precision and optical instruments, watches and clocks	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				
Manufacture of other transport 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				
Manufacture of furniture; manufacturing	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				
Electricity, gas, steam and hot water supply	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				
Collection, purification and distribution of water	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	All Scenarios						Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
	<i>Attributable Fraction</i>																					
Construction	2.10	2.03	1.93	1.69	1.38	1.12	1.92	1.42	0.63	0.07	1.92	1.44	0.69	0.16	1.92	1.47	0.80	0.34				
Land transport, transport via pipelines	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	0.00	0.00	0.00	0.00
Water Transport	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	0.00	0.00	0.00	0.00
Air Transport	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	0.00	0.00	0.00	0.00
Services allied to transport	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	0.00	0.00	0.00	0.00
Real estate activities	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	0.00	0.00	0.00	0.00
Research and development	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	0.00	0.00	0.00	0.00
Other business activities	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	0.00	0.00	0.00	0.00
Education	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	0.00	0.00	0.00	0.00
Health and Social Work	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	0.00	0.00	0.00	0.00
Other community social and personal service activities	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	0.00	0.00	0.00	0.00

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
Attributable Deaths																		
Agriculture, hunting and forestry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fishing, Fish farming and related service activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining of coal and lignite; extraction of peat	56	46	24	7	0	0	24	7	0	0	24	7	0	0	24	7	0	0
Extraction of crude petroleum and natural gas	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining of metal ores	16	18	19	18	14	11	19	15	7	1	19	15	8	1	19	16	9	3
Other mining and quarrying	85	92	96	88	72	56	96	76	35	3	96	76	38	7	96	78	43	16
Manufacture of food products, beverages and tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of textiles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of wearing apparel; dressing and dyeing of fur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanning and dressing of	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m ⁵				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m ⁵				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m ⁵			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
Attributable Deaths																		
leather; manufacture of luggage, handbags, saddlery, harness and footwear																		
Manufacture of pulp, paper and paper products; publishing and printing	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Publishing, printing and reproduction of recorded media	4	4	4	4	3	2	4	3	1	0	4	3	1	0	4	3	2	1
Manufacture of coke, refined petroleum products and nuclear fuel	0	1	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
Manufacture of chemicals and chemical products	2	2	2	2	2	1	2	2	1	0	2	2	1	0	2	2	1	0
Manufacture of rubber and plastic products	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of other non-metallis mineral products	558	620	662	625	525	419	659	533	253	26	659	540	274	61	660	552	314	127
Manufacture of Basic Metals	73	80	84	78	63	49	84	67	31	3	84	67	34	7	84	69	38	15

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
Attributable Deaths																		
Manufacture of fabricated metal products, except machinery and equipment	74	82	86	80	67	53	86	69	32	3	86	70	35	8	86	71	40	16
Manufacture of machinery and equipment	60	66	69	64	52	41	69	55	26	3	69	55	28	6	69	57	32	12
Manufacture of electrical machinery and apparatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of medical, precision and optical instruments, watches and clocks	6	4	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
Manufacture of other transport equipment	6	6	6	6	5	4	6	5	2	0	6	5	3	0	6	5	3	1
Manufacture of furniture; manufacturing	8	8	9	8	7	5	9	7	3	0	9	7	3	1	9	7	4	2
Electricity, gas, steam and hot water supply	12	13	13	12	10	7	13	11	5	0	13	11	5	1	13	11	6	2
Collection, purification and distribution of water	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
Attributable Deaths																		
Construction	5,893	6,663	7,293	7,095	6,133	5,036	7,253	5,973	2,797	298	7,255	6,052	3,059	725	7,261	6,199	3,551	1,526
Land transport, transport via pipelines	12	7	2	0	0	0	2	0	0	0	2	0	0	0	2	0	0	0
Water Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Services allied to transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Real estate activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Research and development	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other business activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Health and Social Work	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other community social and personal service activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Scenario	All Scenarios						Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
Attributable Registrations																						
Agriculture, hunting and forestry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fishing, Fish farming and related service activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining of coal and lignite; extraction of peat	63	50	26	7	0	0	26	7	0	0	26	7	0	0	26	7	0	0	26	7	0	0
Extraction of crude petroleum and natural gas	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining of metal ores	18	20	21	19	15	11	20	16	7	1	20	16	8	1	20	16	9	3	20	16	9	3
Other mining and quarrying	94	101	103	93	74	57	103	80	36	3	103	80	39	8	103	82	44	16	103	82	44	16
Manufacture of food products, beverages and tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of textiles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of wearing apparel; dressing and dying of fur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of pulp, paper and paper products; publishing and printing	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Publishing, printing and reproduction of recorded media	4	4	4	4	3	2	4	3	1	0	4	3	1	0	4	3	2	1	4	3	2	1
Manufacture of coke, refined petroleum products and	1	1	1	1	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
Attributable Registrations																		
nuclear fuel																		
manufacture of chemicals and chemical products	2	2	2	2	2	1	2	2	1	0	2	2	1	0	2	2	1	0
Manufacture of rubber and plastic products	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of other non-metallis mineral products	610	671	704	650	536	424	701	554	258	26	701	561	280	62	701	574	321	129
Manufacture of Basic Metals	80	87	90	81	65	50	89	69	32	3	89	70	34	7	89	72	39	15
Manufacture of fabricated metal products, except machinery and equipment	81	89	92	84	68	53	91	72	33	3	92	72	36	8	92	74	41	17
Manufacture of machinery and equipment	66	71	74	66	53	41	73	57	26	3	73	58	28	6	73	59	32	13
Manufacture of electrical machinery and apparatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of medical, precision and optical instruments, watches and clocks	7	4	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
Manufacture of other transport equipment	6	7	7	6	5	4	7	5	2	0	7	5	3	1	7	5	3	1
Manufacture of furniture; manufacturing	8	9	9	8	7	5	9	7	3	0	9	7	4	1	9	7	4	2
Electricity, gas, steam and hot water supply	13	14	14	13	10	8	14	11	5	0	14	11	5	1	14	11	6	2
Collection, purification and distribution of water	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	6,574	7,351	7,896	7,506	6,363	5,167	7,853	6,319	2,902	305	7,856	6,402	3,173	744	7,861	6,558	3,684	1,565

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
Attributable Registrations																		
Land transport, transport via pipelines	13	8	2	0	0	0	2	0	0	0	2	0	0	0	2	0	0	0
Water Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Services allied to transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Real estate activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Research and development	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other business activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Health and Social Work	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other community social and personal service activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Scenario	All Scenarios						Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
Attributable Years of Life Lost (YLLs)																						
Agriculture, hunting and forestry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fishing, Fish farming and related service activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining of coal and lignite; extraction of peat	851	670	339	89	0	0	339	89	0	0	339	89	0	0	339	89	0	0	339	89	0	0
Extraction of crude petroleum and natural gas	13	9	2	0	0	0	2	0	0	0	2	0	0	0	2	0	0	0	2	0	0	0
Mining of metal ores	243	263	268	235	182	137	266	201	89	7	267	204	96	18	267	208	109	38	267	208	109	38
Other mining and quarrying	1,278	1,356	1,345	1,169	909	688	1,339	1,003	443	36	1,339	1,014	477	91	1,340	1,035	542	196	1,340	1,035	542	196
Manufacture of food products, beverages and tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of textiles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of wearing apparel; dressing and dying of fur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of pulp, paper and paper products; publishing and printing	29	16	2	0	0	0	2	0	0	0	2	0	0	0	2	0	0	0	2	0	0	0
Publishing, printing and reproduction of recorded media	59	61	58	48	35	25	58	42	18	1	58	42	19	3	58	43	21	7	58	43	21	7
Manufacture of coke, refined petroleum products and nuclear fuel	7	8	8	7	5	4	7	6	2	0	7	6	3	1	7	6	3	1	7	6	3	1
Manufacture of chemicals and chemical products	28	30	31	27	22	17	31	23	10	1	31	24	11	2	31	24	13	5	31	24	13	5

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m ⁵				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m ⁵				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m ⁵			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
Attributable Years of Life Lost (YLLs)																		
Manufacture of rubber and plastic products	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of other non-metallis mineral products	8,600	9,284	9,470	8,475	6,803	5,294	9,422	7,224	3,272	323	9,426	7,313	3,553	773	9,432	7,479	4,074	1,607
Manufacture of Basic Metals	1,124	1,202	1,204	1,052	822	624	1,198	902	401	37	1,198	912	434	88	1,199	931	494	185
Manufacture of fabricated metal products, except machinery and equipment	1,145	1,226	1,233	1,087	861	663	1,227	931	419	43	1,228	942	456	101	1,228	963	522	207
Manufacture of machinery and equipment	922	986	988	864	677	516	984	741	331	32	984	750	359	76	984	766	410	157
Manufacture of electrical machinery and apparatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of medical, precision and optical instruments, watches and clocks	98	55	8	1	0	0	8	1	0	0	8	1	0	0	8	1	0	0
Manufacture of other transport equipment	87	92	91	80	62	48	91	68	30	3	91	69	33	6	91	70	37	14
Manufacture of furniture; manufacturing	118	125	125	109	85	65	124	94	42	4	124	95	45	9	125	97	52	20
Electricity, gas, steam and hot water supply	183	193	190	163	125	92	190	141	61	5	190	142	66	12	190	145	74	25
Collection, purification and distribution of water	27	17	4	1	0	0	4	1	0	0	4	1	0	0	4	1	0	0
Construction	88,408	97,043	101,504	93,658	77,415	61,921	100,941	78,854	35,312	3,659	100,980	79,888	38,615	8,909	101,053	81,836	44,826	18,756
Land transport, transport via pipelines	183	109	26	5	0	0	26	5	0	0	26	5	0	0	26	5	0	0
Water Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Services allied to transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Real estate activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
<i>Attributable Years of Life Lost (YLLs)</i>																		
Research and development	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other business activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Health and Social Work	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other community social and personal service activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
<i>Attributable Years of Life Lived with Disability (DALYs)</i>																		
Agriculture, hunting and forestry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fishing, Fish farming and related service activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining of coal and lignite; extraction of peat	889	700	354	93	0	0	354	93	0	0	354	93	0	0	354	93	0	0
Extraction of crude petroleum and natural gas	14	9	3	0	0	0	3	0	0	0	3	0	0	0	3	0	0	0
Mining of metal ores	253	275	280	245	191	143	278	211	93	7	279	213	100	19	279	217	114	40
Other mining and quarrying	1,334	1,416	1,406	1,223	951	720	1,399	1,049	464	38	1,400	1,061	499	95	1,401	1,082	568	205
Manufacture of food products, beverages and tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of textiles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of wearing apparel; dressing and dyeing of fur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of pulp, paper and paper products; publishing and printing	30	17	2	0	0	0	2	0	0	0	2	0	0	0	2	0	0	0
Publishing, printing and reproduction of recorded media	62	64	61	50	37	26	61	44	18	1	61	44	20	3	61	45	22	7
Manufacture of coke, refined petroleum products and nuclear fuel	8	8	8	7	5	4	8	6	3	0	8	6	3	1	8	6	3	1
Manufacture of chemicals and chemical products	30	32	32	29	23	18	32	24	11	1	32	25	12	2	32	25	13	5

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
<i>Attributable Years of Life Lived with Disability (DALYs)</i>																		
Manufacture of rubber and plastic products	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of other non-metallis mineral products	8,975	9,691	9,890	8,857	7,115	5,538	9,840	7,550	3,422	338	9,844	7,643	3,715	809	9,850	7,816	4,260	1,682
Manufacture of Basic Metals	1,174	1,255	1,257	1,099	860	653	1,251	942	420	38	1,252	953	454	92	1,252	973	517	193
Manufacture of fabricated metal products, except machinery and equipment	1,195	1,279	1,288	1,136	901	694	1,282	972	439	45	1,282	985	477	106	1,283	1,007	546	217
Manufacture of machinery and equipment	962	1,030	1,032	903	708	540	1,027	774	347	34	1,028	783	375	80	1,028	800	429	164
Manufacture of electrical machinery and apparatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of medical, precision and optical instruments, watches and clocks	102	57	9	1	0	0	9	1	0	0	9	1	0	0	9	1	0	0
Manufacture of other transport equipment	91	96	95	83	65	50	95	71	32	3	95	72	34	7	95	74	39	14
Manufacture of furniture; manufacturing	123	131	131	114	89	68	130	98	44	4	130	99	47	10	130	101	54	21
Electricity, gas, steam and hot water supply	191	202	199	171	130	96	198	147	64	5	198	149	69	12	198	151	78	26
Collection, purification and distribution of water	28	17	4	1	0	0	4	1	0	0	4	1	0	0	4	1	0	0
Construction	92,354	101,401	106,110	97,972	81,037	64,844	105,522	82,487	36,965	3,832	105,563	83,568	40,422	9,330	105,639	85,606	46,924	19,642
Land transport, transport via pipelines	192	114	27	6	0	0	27	6	0	0	27	6	0	0	27	6	0	0
Water Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Services allied to transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Real estate activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Scenario	All Scenarios		Baseline (trend) scenario (1) ^[2] - Linear employment and exposure level trends assumed to 2021-30, constant thereafter.				Intervention scenario (2) - Full compliance for OEL = 0.05 mg/m5				Intervention scenario (3) - Full compliance for OEL = 0.1 mg/m5				Intervention scenario (4) - Full compliance for OEL = 0.2 mg/m5			
Industry sector	2010	2020	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060	2030	2040	2050	2060
<i>Attributable Years of Life Lived with Disability (DALYs)</i>																		
Research and development	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other business activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Health and Social Work	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other community social and personal service activities	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

[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

8.5 VALUING HEALTH BENEFITS – INTERVENTION SCENARIOS

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

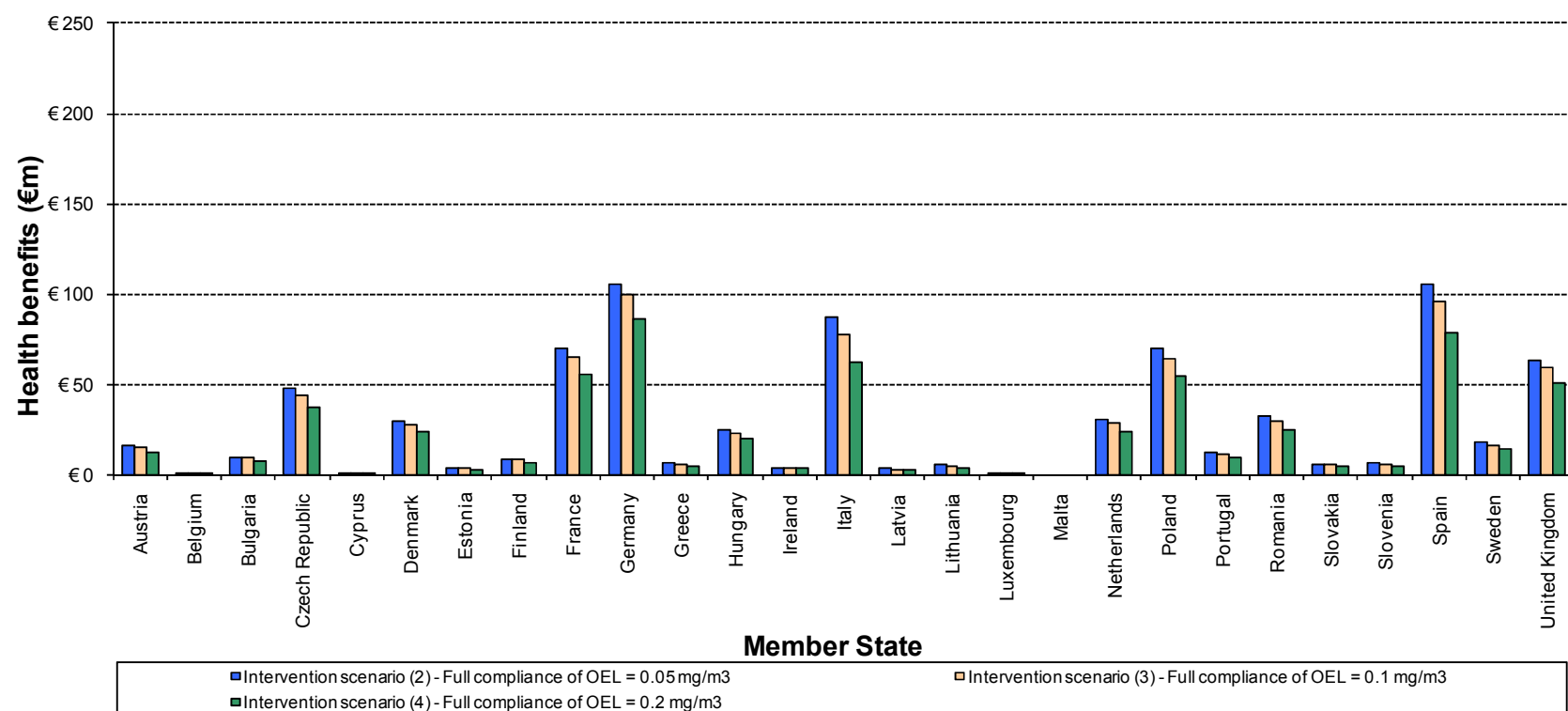


Figure 8.5.1 Total health benefits to females of introducing an EU wide OEL – By Member State – Low Scenario (Present Value – 2010 €m prices)

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

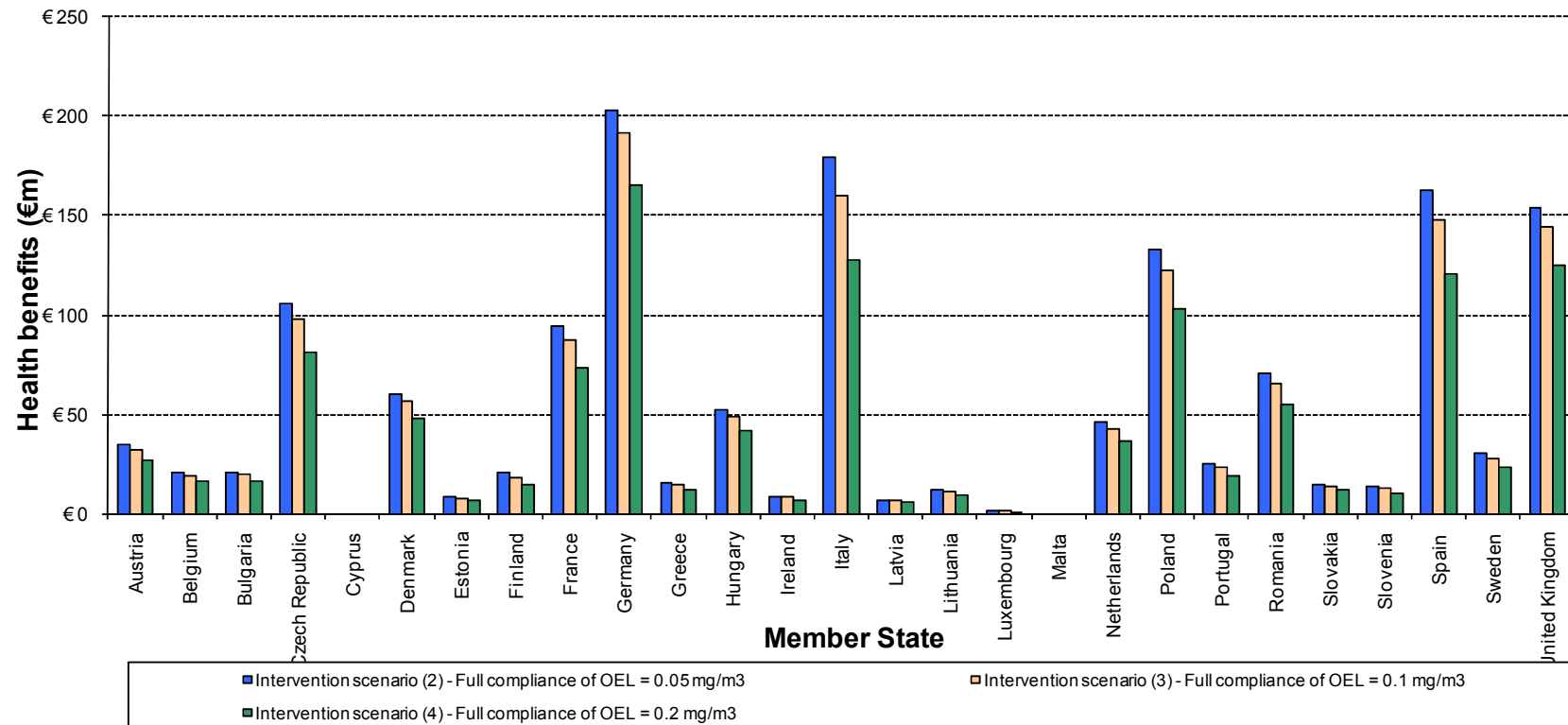


Figure 8.5.2 Total health benefits for females of introducing an EU wide OEL – By Member State – High Scenario (Present Value – 2010 €m prices)

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

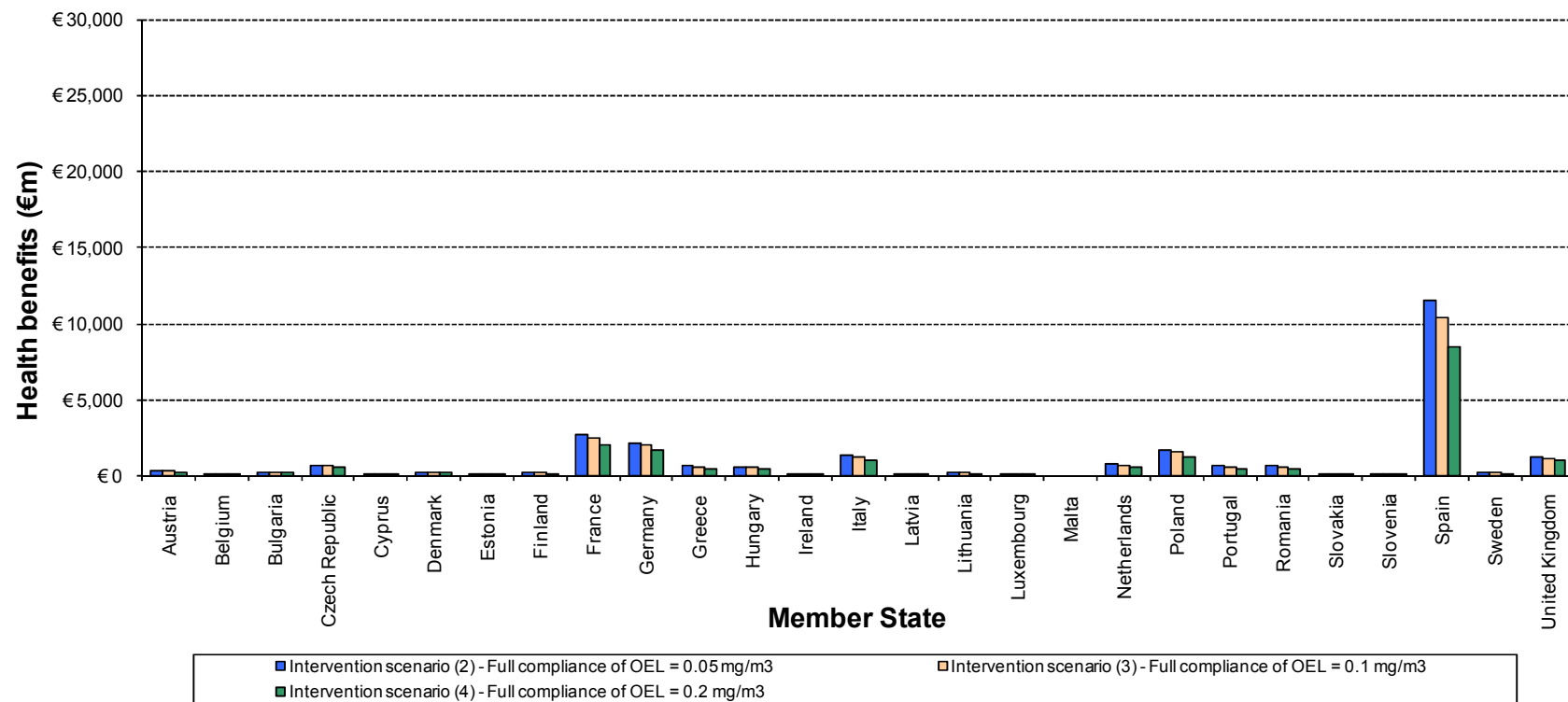


Figure 8.5.3 Total health benefits to males of introducing an EU wide OEL – By Member State – Low Scenario (Present Value – 2010 €m prices)

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

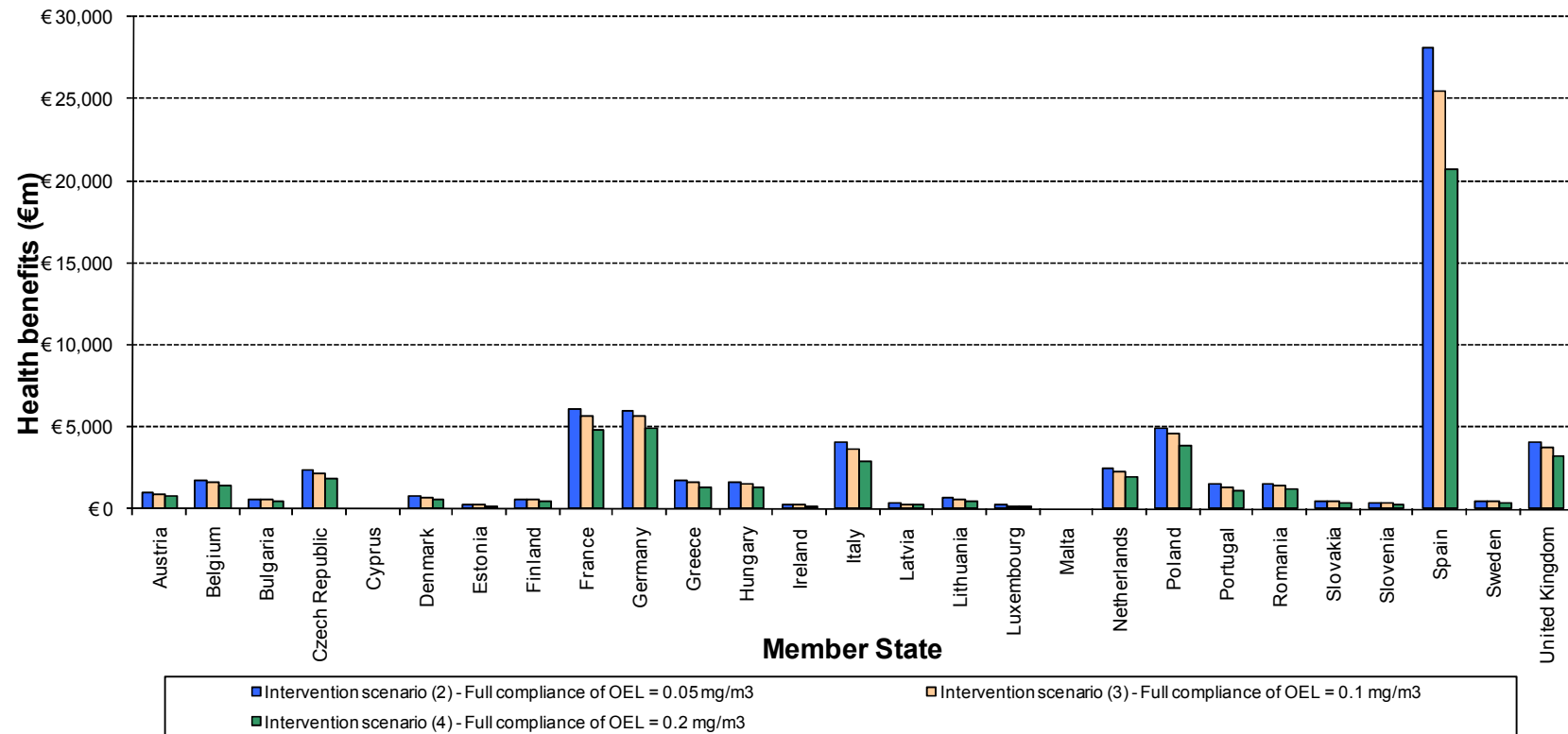


Figure 8.5.4 Total health benefits for males of introducing an EU wide OEL – By Member State – High Scenario (Present Value – 2010 €m prices)

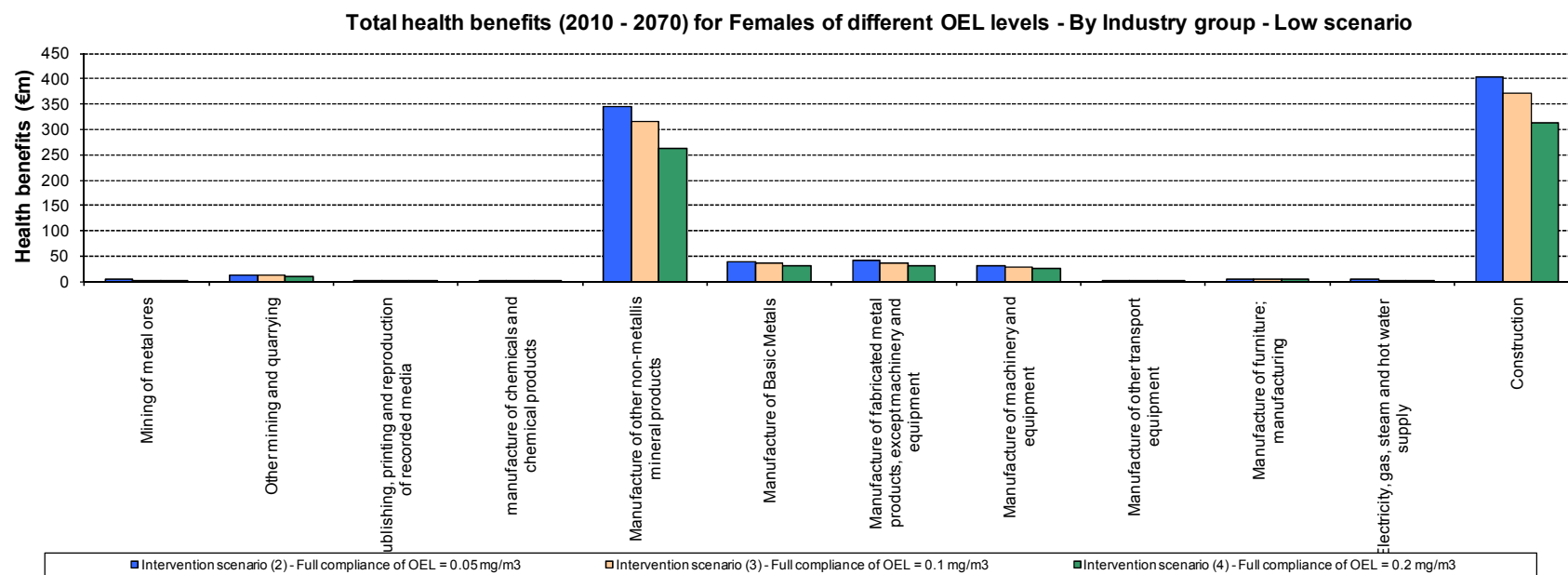


Figure 8.5.5 Total health benefits to females of introducing an EU wide OEL – By Industry Group – Low Scenario (Present Value – 2010 €m prices)

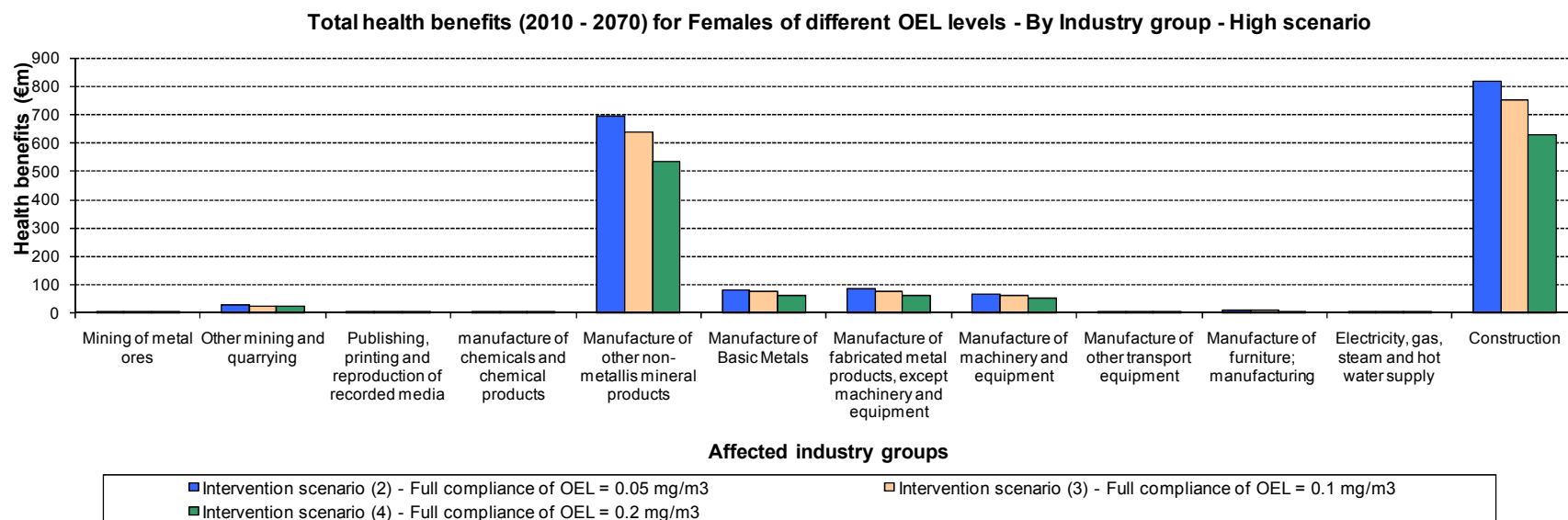


Figure 8.5.6 Total health benefits for females of introducing an EU wide OEL – By Industry Group – High Scenario (Present Value – 2010 €m prices)

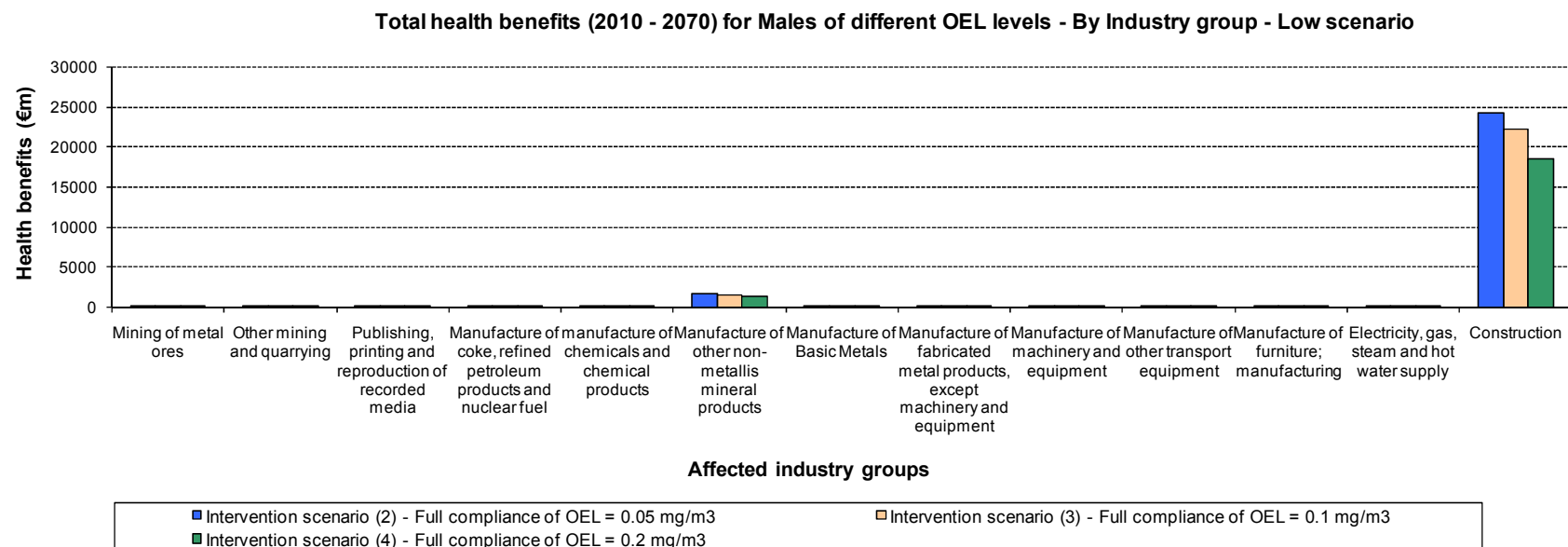


Figure 8.5.7 Total health benefits to males of introducing an EU wide OEL – By Industry Group – Low Scenario (Present Value – 2010 €m prices)

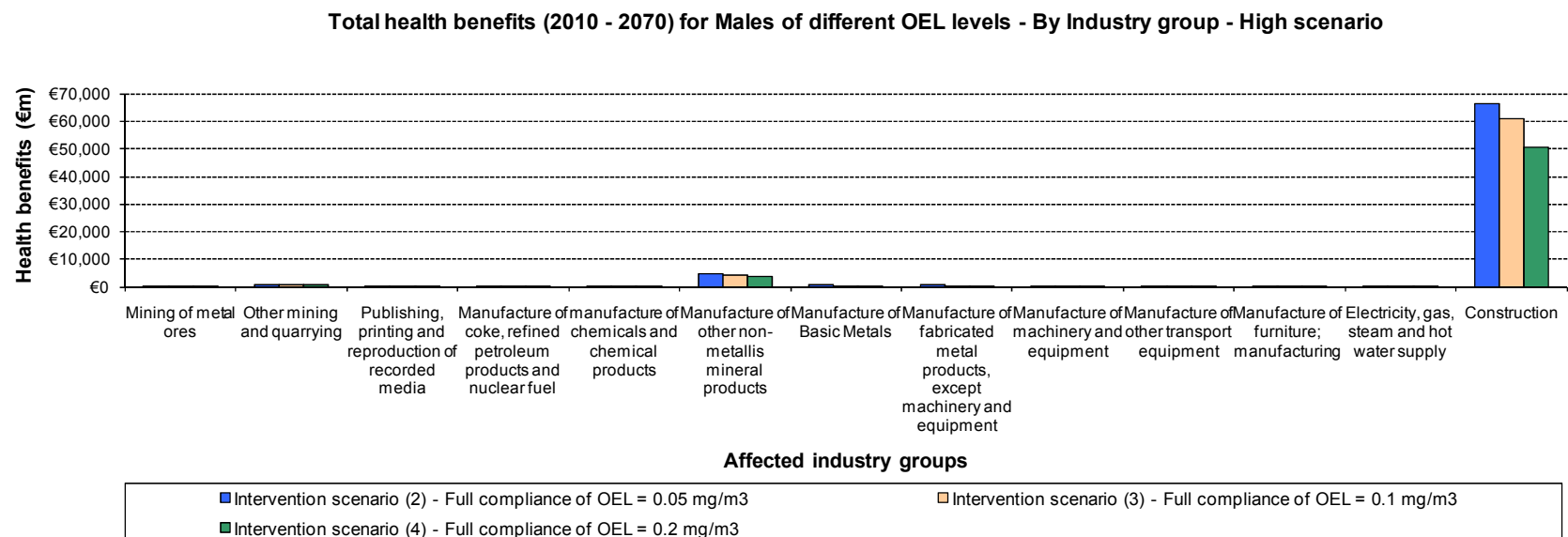


Figure 8.5.8 Total health benefits for males of introducing an EU wide OEL – By Member State – High Scenario (Present Value – 2010 €m prices)

8.6 HEALTH BENEFITS USING DIFFERENT DISCOUNT RATES

COLOUR KEY
No discount
Using the EU IA guidance - 4%
Using a declining discount rate (4% going to 3%)

Table 8.6.1 Introducing an OEL of 0.05 mg/m³

Respirable Crystalline Silica		Intervention option 1 - Introduce OEL=0.05 mg/m ³					
Range of costs (€m)	Gender	2010-2019	2020-2029	2030-2039	2040-2049	2050-2059	2060-2069
	Females	0 to 0	0 to 0	16 to 30	511 to 964	1741 to 3377	2906 to 5737
	Males	0 to 0	0 to 0	538 to 1358	17492 to 45427	61163 to 163497	103604 to 281764
	Totals	0 to 0	0 to 0	555 to 1387	18003 to 46391	62903 to 166875	106510 to 287501
	Gender	2010-2019	2020-2029	2030-2039	2040-2049	2050-2059	2060-2069
	Females	0 to 0	0 to 0	6 to 11	130 to 244	298 to 578	336 to 664
	Males	0 to 0	0 to 0	202 to 509	4433 to 11512	10471 to 27991	11982 to 32588
	Totals	0 to 0	0 to 0	208 to 520	4562 to 11756	10769 to 28569	12319 to 33251
	Gender	2010-2019	2020-2029	2030-2039	2040-2049	2050-2059	2060-2069
	Females	0 to 0	0 to 0	8 to 14	182 to 343	460 to 893	572 to 1129
	Males	0 to 0	0 to 0	257 to 648	6216 to 16144	16174 to 43235	20386 to 55442
	Totals	0 to 0	0 to 0	265 to 663	6398 to 16487	16634 to 44128	20958 to 56571

Member State	Low cost	High cost	Low cost	High cost	Low cost	High cost
Austria	€ 2,545	€ 7,121	€ 379	€ 1,057	€ 601	€ 1,678
Belgium	€ 335	€ 324	€ 50	€ 1,809	€ 79	€ 2,872
Bulgaria	€ 1,794	€ 1,739	€ 270	€ 611	€ 427	€ 969
Czech Republic	€ 5,343	€ 5,159	€ 796	€ 2,468	€ 1,262	€ 3,925
Cyprus	€ 185	€ 179	€ 27	€ 0	€ 43	€ 0
Denmark	€ 2,086	€ 2,025	€ 311	€ 815	€ 493	€ 1,293
Estonia	€ 600	€ 582	€ 89	€ 269	€ 141	€ 429
Finland	€ 1,594	€ 1,529	€ 236	€ 627	€ 375	€ 997

Member State	Low cost	High cost	Low cost	High cost	Low cost	High cost
France	€ 18,460	€ 17,890	€ 2,766	€ 6,231	€ 4,381	€ 9,872
Germany	€ 15,120	€ 14,748	€ 2,262	€ 6,233	€ 3,584	€ 9,883
Greece	€ 4,531	€ 4,376	€ 674	€ 1,750	€ 1,070	€ 2,780
Hungary	€ 3,993	€ 3,875	€ 596	€ 1,720	€ 945	€ 2,734
Ireland	€ 628	€ 612	€ 93	€ 258	€ 148	€ 410
Italy	€ 9,897	€ 9,455	€ 1,466	€ 4,295	€ 2,329	€ 6,827
Latvia	€ 827	€ 803	€ 123	€ 330	€ 195	€ 525
Lithuania	€ 1,500	€ 1,452	€ 222	€ 650	€ 353	€ 1,036
Luxembourg	€ 439	€ 421	€ 65	€ 219	€ 103	€ 349
Malta	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Netherlands	€ 5,524	€ 5,363	€ 823	€ 2,550	€ 1,306	€ 4,046
Poland	€ 11,771	€ 11,404	€ 1,747	€ 5,109	€ 2,775	€ 8,129
Portugal	€ 4,662	€ 4,488	€ 691	€ 1,530	€ 1,098	€ 2,434
Romania	€ 4,546	€ 4,404	€ 683	€ 1,621	€ 1,081	€ 2,575
Slovakia	€ 969	€ 942	€ 144	€ 505	€ 229	€ 804
Slovenia	€ 1,043	€ 1,008	€ 155	€ 417	€ 246	€ 662
Spain	€ 79,134	€ 76,209	€ 11,629	€ 28,270	€ 18,515	€ 45,082
Sweden	€ 1,554	€ 1,509	€ 231	€ 548	€ 367	€ 871
United Kingdom	€ 8,891	€ 8,665	€ 1,331	€ 4,205	€ 2,109	€ 6,665

Industry Group	Low cost	High cost	Low cost	High cost	Low cost	High cost
Agriculture, hunting and forestry	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Fishing, Fish farming and related service activities	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Mining of coal and lignite; extraction of peat	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Extraction of crude petroleum and natural gas	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Mining of metal ores	€ 370	€ 995	€ 55	€ 147	€ 87	€ 234
Other mining and quarrying	€ 1,859	€ 5,018	€ 276	€ 741	€ 438	€ 1,179
Manufacture of food products, beverages and tobacco	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of textiles	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of wearing apparel; dressing and dyeing of fur	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0

Industry Group	Low cost	High cost	Low cost	High cost	Low cost	High cost
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of pulp, paper and paper products; publishing and printing	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Publishing, printing and reproduction of recorded media	€ 69	€ 180	€ 10	€ 27	€ 16	€ 42
Manufacture of coke, refined petroleum products and nuclear fuel	€ 10	€ 27	€ 2	€ 4	€ 2	€ 6
Manufacture of chemicals and chemical products	€ 45	€ 119	€ 7	€ 18	€ 11	€ 28
Manufacture of rubber and plastic products	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of other non-metallis mineral products	€ 14,096	€ 36,919	€ 2,087	€ 5,447	€ 3,317	€ 8,663
Manufacture of Basic Metals	€ 1,672	€ 4,382	€ 248	€ 648	€ 394	€ 1,029
Manufacture of fabricated metal products, except machinery and equipment	€ 1,761	€ 4,619	€ 261	€ 682	€ 414	€ 1,084
Manufacture of machinery and equipment	€ 1,376	€ 3,610	€ 204	€ 533	€ 324	€ 848
Manufacture of electrical machinery and apparatus	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of medical, precision and optical instruments, watches and clocks	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of other transport equipment	€ 128	€ 337	€ 19	€ 50	€ 30	€ 79
Manufacture of furniture; manufacturing	€ 173	€ 452	€ 26	€ 67	€ 41	€ 106
Electricity, gas, steam and hot water supply	€ 250	€ 668	€ 37	€ 99	€ 59	€ 157
Collection, purification and distribution of water	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Construction	€ 166,845	€ 454,356	€ 24,747	€ 67,153	€ 39,304	€ 106,757

Industry Group	Low cost	High cost	Low cost	High cost	Low cost	High cost
Land transport, transport via pipelines	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Water Transport	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Air Transport	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Services allied to transport	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Real estate activities	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Research and development	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Other business activities	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Education	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Health and Social Work	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Other community social and personal service activities	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
TOTAL	€ 188,655	€ 511,683	€ 27,978	€ 75,614	€ 44,437	€ 120,213

Table 8.6.2 Introducing an OEL of 0.1mg/m³

Respirable Crystalline Silica		Intervention option 2 - Introduce OEL=0.1 mg/m ³					
Range of costs (€m)	Gender	2010-2019	2020-2029	2030-2039	2040-2049	2050-2059	2060-2069
	Females	0 to 0	0 to 0	15 to 28	477 to 900	1611 to 3127	2659 to 5251
	Males	0 to 0	0 to 0	501 to 1265	16253 to 42240	56258 to 150494	94017 to 255911
	Totals	0 to 0	0 to 0	516 to 1292	16730 to 43139	57870 to 153621	96676 to 261161
	Gender	2010-2019	2020-2029	2030-2039	2040-2049	2050-2059	2060-2069
	Females	0 to 0	0 to 0	6 to 10	121 to 228	276 to 535	308 to 607
	Males	0 to 0	0 to 0	188 to 474	4119 to 10704	9631 to 25764	10874 to 29597
	Totals	0 to 0	0 to 0	194 to 485	4240 to 10932	9907 to 26300	11181 to 30205
	Gender	2010-2019	2020-2029	2030-2039	2040-2049	2050-2059	2060-2069
	Females	0 to 0	0 to 0	7 to 13	170 to 320	426 to 827	523 to 1033
	Males	0 to 0	0 to 0	239 to 604	5776 to 15011	14877 to 39797	18500 to 50355
	Totals	0 to 0	0 to 0	247 to 617	5946 to 15331	15303 to 40623	19023 to 51388

Member State	Low cost	High cost	Low cost	High cost	Low cost	High cost
Austria	€ 2,343	€ 2,187	€ 349	€ 975	€ 554	€ 1,547
Belgium	€ 308	€ 288	€ 46	€ 1,671	€ 73	€ 2,651
Bulgaria	€ 1,662	€ 1,554	€ 251	€ 567	€ 396	€ 899
Czech Republic	€ 4,887	€ 4,548	€ 729	€ 2,262	€ 1,157	€ 3,595
Cyprus	€ 170	€ 159	€ 25	€ 0	€ 40	€ 0
Denmark	€ 1,933	€ 1,811	€ 289	€ 757	€ 458	€ 1,200
Estonia	€ 554	€ 518	€ 82	€ 249	€ 130	€ 396
Finland	€ 1,429	€ 1,317	€ 212	€ 564	€ 337	€ 896
France	€ 17,069	€ 15,949	€ 2,562	€ 5,773	€ 4,057	€ 9,142
Germany	€ 14,193	€ 13,396	€ 2,127	€ 5,861	€ 3,369	€ 9,289
Greece	€ 4,145	€ 3,854	€ 618	€ 1,604	€ 981	€ 2,547
Hungary	€ 3,702	€ 3,466	€ 554	€ 1,597	€ 877	€ 2,538
Ireland	€ 588	€ 554	€ 87	€ 242	€ 139	€ 384
Italy	€ 8,796	€ 8,067	€ 1,306	€ 3,826	€ 2,074	€ 6,078
Latvia	€ 765	€ 717	€ 114	€ 306	€ 180	€ 486
Lithuania	€ 1,378	€ 1,287	€ 204	€ 598	€ 324	€ 953
Luxembourg	€ 395	€ 364	€ 58	€ 198	€ 93	€ 315
Malta	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Netherlands	€ 5,119	€ 4,796	€ 764	€ 2,368	€ 1,212	€ 3,755
Poland	€ 10,849	€ 10,150	€ 1,614	€ 4,717	€ 2,561	€ 7,502
Portugal	€ 4,224	€ 3,910	€ 628	€ 1,389	€ 997	€ 2,209
Romania	€ 4,202	€ 3,927	€ 632	€ 1,500	€ 1,000	€ 2,383
Slovakia	€ 900	€ 845	€ 134	€ 470	€ 213	€ 748
Slovenia	€ 957	€ 891	€ 143	€ 383	€ 226	€ 608
Spain	€ 71,447	€ 66,180	€ 10,527	€ 25,587	€ 16,749	€ 40,774
Sweden	€ 1,441	€ 1,351	€ 215	€ 509	€ 340	€ 809
United Kingdom	€ 8,335	€ 7,857	€ 1,250	€ 3,949	€ 1,980	€ 6,257

Industry Group	Low cost	High cost	Low cost	High cost	Low cost	High cost
Agriculture, hunting and forestry	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Fishing, Fish farming and related service activities	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Mining of coal and lignite; extraction of peat	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Extraction of crude petroleum and natural gas	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Mining of metal ores	€ 342	€ 919	€ 51	€ 136	€ 81	€ 216
Other mining and quarrying	€ 1,714	€ 4,626	€ 255	€ 685	€ 404	€ 1,088
Manufacture of food products, beverages and tobacco	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of textiles	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0

Industry Group	Low cost	High cost	Low cost	High cost	Low cost	High cost
Manufacture of wearing apparel; dressing and dyeing of fur	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of pulp, paper and paper products; publishing and printing	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Publishing, printing and reproduction of recorded media	€ 64	€ 167	€ 10	€ 25	€ 15	€ 39
Manufacture of coke, refined petroleum products and nuclear fuel	€ 10	€ 25	€ 1	€ 4	€ 2	€ 6
Manufacture of chemicals and chemical products	€ 42	€ 109	€ 6	€ 16	€ 10	€ 26
Manufacture of rubber and plastic products	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of other non-metalliferous mineral products	€ 12,899	€ 33,779	€ 1,914	€ 4,994	€ 3,040	€ 7,939
Manufacture of Basic Metals	€ 1,535	€ 4,022	€ 228	€ 595	€ 362	€ 946
Manufacture of fabricated metal products, except machinery and equipment	€ 1,606	€ 4,212	€ 238	€ 623	€ 379	€ 990
Manufacture of machinery and equipment	€ 1,259	€ 3,303	€ 187	€ 489	€ 297	€ 777
Manufacture of electrical machinery and apparatus	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of medical, precision and optical instruments, watches and clocks	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of other transport equipment	€ 118	€ 310	€ 18	€ 46	€ 28	€ 73
Manufacture of furniture; manufacturing	€ 159	€ 414	€ 24	€ 61	€ 37	€ 97
Electricity, gas, steam and hot water supply	€ 232	€ 618	€ 34	€ 92	€ 55	€ 146

Industry Group	Low cost	High cost	Low cost	High cost	Low cost	High cost
Collection, purification and distribution of water	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Construction	€ 152,799	€ 416,063	€ 22,715	€ 61,632	€ 36,055	€ 97,922
Land transport, transport via pipelines	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Water Transport	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Air Transport	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Services allied to transport	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Real estate activities	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Research and development	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Other business activities	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Education	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Health and Social Work	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Other community social and personal service activities	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
TOTAL	€ 172,776	€ 468,567	€ 25,681	€ 69,399	€ 40,765	€ 110,266

Table 8.6.3 Introducing an OEL of 0.2mg/m³

Respirable Crystalline Silica		Intervention option 2 - Introduce OEL=0.1 mg/m ³					
Range of costs (€m)	Gender	2010-2019	2020-2029	2030-2039	2040-2049	2050-2059	2060-2069
	Females	0 to 0	0 to 0	5 to 9	162 to 302	529 to 1016	838 to 1629
	Males	0 to 0	0 to 0	179 to 451	5706 to 14812	18765 to 50169	29467 to 80085
	Totals	0 to 0	0 to 0	184 to 460	5868 to 15113	19295 to 51185	30305 to 81714
	Gender	2010-2019	2020-2029	2030-2039	2040-2049	2050-2059	2060-2069
	Females	0 to 0	0 to 0	2 to 3	41 to 76	91 to 174	97 to 188
	Males	0 to 0	0 to 0	67 to 169	1446 to 3753	3213 to 8589	3408 to 9262
	Totals	0 to 0	0 to 0	69 to 173	1487 to 3830	3303 to 8763	3505 to 9451
	Gender	2010-2019	2020-2029	2030-2039	2040-2049	2050-2059	2060-2069
	Females	0 to 0	0 to 0	2 to 4	57 to 107	140 to 269	165 to 321
	Males	0 to 0	0 to 0	85 to 215	2028 to 5264	4962 to 13267	5798 to 15758
	Totals	0 to 0	0 to 0	88 to 220	2085 to 5371	5102 to 13535	5963 to 16079

Member State	Low cost	High cost	Low cost	High cost	Low cost	High cost
Austria	€ 1,074	€ 1,953	€ 293	€ 817	€ 464	€ 1,294
Belgium	€ 142	€ 257	€ 39	€ 1,402	€ 61	€ 2,221
Bulgaria	€ 744	€ 1,402	€ 213	€ 480	€ 336	€ 761
Czech Republic	€ 2,204	€ 4,047	€ 607	€ 1,882	€ 962	€ 2,987
Cyprus	€ 80	€ 142	€ 21	€ 0	€ 33	€ 0
Denmark	€ 892	€ 1,627	€ 244	€ 640	€ 387	€ 1,014
Estonia	€ 257	€ 463	€ 69	€ 209	€ 109	€ 332
Finland	€ 640	€ 1,147	€ 171	€ 455	€ 271	€ 722
France	€ 7,735	€ 14,335	€ 2,163	€ 4,872	€ 3,419	€ 7,705
Germany	€ 6,620	€ 12,209	€ 1,839	€ 5,065	€ 2,909	€ 8,018
Greece	€ 1,874	€ 3,422	€ 513	€ 1,331	€ 813	€ 2,111
Hungary	€ 1,694	€ 3,119	€ 469	€ 1,352	€ 742	€ 2,145
Ireland	€ 278	€ 503	€ 75	€ 208	€ 119	€ 330
Italy	€ 3,875	€ 6,981	€ 1,042	€ 3,053	€ 1,653	€ 4,843
Latvia	€ 355	€ 644	€ 96	€ 258	€ 152	€ 411
Lithuania	€ 637	€ 1,146	€ 171	€ 500	€ 271	€ 795
Luxembourg	€ 177	€ 318	€ 47	€ 160	€ 75	€ 254
Malta	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Netherlands	€ 2,362	€ 4,310	€ 647	€ 2,004	€ 1,024	€ 3,173
Poland	€ 4,990	€ 9,096	€ 1,360	€ 3,973	€ 2,156	€ 6,311
Portugal	€ 1,900	€ 3,437	€ 514	€ 1,136	€ 814	€ 1,803
Romania	€ 1,886	€ 3,535	€ 535	€ 1,268	€ 845	€ 2,011
Slovakia	€ 417	€ 761	€ 114	€ 399	€ 180	€ 634
Slovenia	€ 435	€ 793	€ 119	€ 319	€ 188	€ 506
Spain	€ 32,619	€ 57,673	€ 8,551	€ 20,773	€ 13,583	€ 33,049
Sweden	€ 670	€ 1,214	€ 182	€ 431	€ 288	€ 684
United Kingdom	€ 3,867	€ 7,158	€ 1,079	€ 3,407	€ 1,706	€ 5,390

Industry Group	Low cost	High cost	Low cost	High cost	Low cost	High cost
Agriculture, hunting and forestry	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Fishing, Fish farming and related service activities	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Mining of coal and lignite; extraction of peat	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Extraction of crude petroleum and natural gas	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Mining of metal ores	€ 287	€ 771	€ 43	€ 115	€ 68	€ 182
Other mining and quarrying	€ 1,434	€ 3,869	€ 214	€ 576	€ 340	€ 914
Manufacture of food products, beverages and tobacco	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of textiles	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of wearing apparel; dressing and dyeing of fur	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0

Industry Group	Low cost	High cost	Low cost	High cost	Low cost	High cost
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of pulp, paper and paper products; publishing and printing	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Publishing, printing and reproduction of recorded media	€ 54	€ 142	€ 8	€ 21	€ 13	€ 34
Manufacture of coke, refined petroleum products and nuclear fuel	€ 8	€ 21	€ 1	€ 3	€ 2	€ 5
Manufacture of chemicals and chemical products	€ 35	€ 91	€ 5	€ 14	€ 8	€ 22
Manufacture of rubber and plastic products	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of other non-metalliferous mineral products	€ 10,678	€ 27,954	€ 1,593	€ 4,155	€ 2,526	€ 6,595
Manufacture of Basic Metals	€ 1,277	€ 3,345	€ 191	€ 498	€ 302	€ 790
Manufacture of fabricated metal products, except machinery and equipment	€ 1,324	€ 3,471	€ 198	€ 516	€ 313	€ 819
Manufacture of machinery and equipment	€ 1,043	€ 2,735	€ 156	€ 407	€ 247	€ 646
Manufacture of electrical machinery and apparatus	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of medical, precision and optical instruments, watches and clocks	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Manufacture of other transport equipment	€ 99	€ 259	€ 15	€ 39	€ 23	€ 61
Manufacture of furniture; manufacturing	€ 131	€ 343	€ 20	€ 51	€ 31	€ 81
Electricity, gas, steam and hot water supply	€ 195	€ 520	€ 29	€ 77	€ 46	€ 123
Collection, purification and distribution of water	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Construction	€ 126,422	€ 344,156	€ 18,898	€ 51,260	€ 29,953	€ 81,327
Land transport, transport via pipelines	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Water Transport	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Air Transport	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Services allied to transport	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Real estate activities	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0

Industry Group	Low cost	High cost	Low cost	High cost	Low cost	High cost
Research and development	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Other business activities	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Education	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Health and Social Work	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Other community social and personal service activities	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
TOTAL	€ 142,986	€ 387,678	€ 21,370	€ 57,732	€ 33,873	€ 91,598

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