

# Counting the Cost of Occupational Cancer

The SHEcan project:

**S**ocio-economic **H**ealth and **E**nvironment and **c**ancer at work

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# Background and Aims

- EU Carcinogens Directive sets minimum standards throughout Europe
- European Commission DG Employment funded project to carry out a socioeconomic, health and environmental impact assessment of possible changes to the Carcinogens Directive
- 25 substances: Modelling the effect of introduction and/or reduction of a workplace exposure limit
- Comparison of costs of predicted future cancers from these changes with costs to industry of implementation

<b>SHEcan Reference</b>	<b>Substance or mixture</b>	<b>EU carcinogen</b>	<b>IARC</b>
1	Hard wood dust	NA	1
2	Vinyl chloride monomer (VCM)	1	1
3	Trichloroethylene	2	2a
4	Beryllium and beryllium compounds	2	1
5	Chrome VI	2	1
6	Acrylamide	2	2a
7	Rubber process fume and dust	NA	1
8	Respirable crystalline silica	NA	1
9	4, 4'-methylenedianiline	2	2b
10	4,4'-methylene bis 2-chloroaniline	2	2a
11	1, 3 Butadiene	1	1
12	Ethylene oxide	2	1
13	Diesel engine exhaust emissions (DEE)	NA	2a
14	Refractory ceramic fibres (RCF)	2	2b
15	Hydrazine	2	2b
16	1, 2-Epoxypropane	2	2b
17	1, 2-Dichloroethane	2	2b
18	1, 2-Dibromoethane	2	2b
19	o-Toluidine	2	1
20	Hexachlorobenzene	2	2b
21	Mineral oils as used engine oil	NA	1
22	Benzo[a]pyrene	2	1
23	2-Nitropropane	2	2b
24	Bromoethylene	2	2a
25	1-Chloro-2, 3-epoxypropane	2	2a

IARC classification:

Group 1: definite human carcinogen

Group 2a: probable human carcinogen

Group 2b: possible human carcinogen

# Method

- Health impact assessment carried out using the methodology developed for the British Cancer Burden study using data on:
  - Current exposures by industry (H/M/L/B); distribution of exposure (GM and GSD); and temporal changes in exposure (% change per year)
  - Risk estimates from key studies, meta-analyses or pooled studies, taking into account quality, relevance to the EU, large sample size, effective control for confounders, adequate exposure assessment, and clear case definition.

<b>Substance or mixture</b>	<b>Estimated number exposed</b>
Benzo[a]pyrene	7,000,000
Diesel engine exhaust emissions	3,600,000
Hard wood dust	3,000,000
Hydrazine	2,100,000
Mineral oils as used engine oil	1,000,000
4, 4' methylenedianiline (MDA)	390,000 - 3,900,000
Chrome VI	920,000
Respirable crystalline silica	720,000
	172,000
Trichloroethylene	74,000
Beryllium and beryllium compounds	65,000
Rubber process fume and dust	57,000
Acrylamide	53,000
2-Nitropropane	50,000
1-Chloro-2, 3-epoxypropane	44,000
1, 3 Butadiene	28,000
Vinyl chloride monomer	19,000
Ethylene oxide	16,000
Refractory ceramic fibres	10,000
o-Toluidine	5,500
1, 2-Dibromoethane	<8,000
4,4'-Methylene bis 2-chloroaniline (MbOCA)	2,500
1, 2-Dichloroethane	<3,000
1, 2-Epoxypropane	<1,200
Bromoethylene	<1,000
Hexachlorobenzene	Unknown

# Costs to business of compliance

- Estimated no. of affected companies, employees, operating surplus, etc. from Eurostat, by size of enterprise where possible
- Reviewed literature and consulted industry on exposure controls currently in place and additional exposure controls needed to comply with stricter OELs
- Compliance cost estimates from consultation and literature normalised to give comparable data:
  - Converted to Euros from other currencies where needed
  - Inflated to a common price year (2010)
  - Discounted future cost streams using the standard EU discount rate of 4% (controversial decision)
- 'administrative' costs also included e.g. potential for company closure if costs of compliance are unaffordable

# Costs of health benefits from reduced OELs

Used **health data estimates** on:

- Cancer registrations over the study period
- Associated years of life lost

Used **several approaches to estimate health impacts** reflecting different methodological approaches and uncertainties:

- Total value of life years lost (VLYL) – a value for the time (in years) lost as a result of premature death = €50,000 per LYL
- Cost of illness (COI) reflecting the direct and indirect costs of cancer = c. €50,000 per cancer registration
- Willingness to pay (WTP) to avoid cancer as an alternative method, including 'intangible' costs e.g. disfigurement, functional limitations, pain and fear = €1.8 million per cancer registration

**Future health costs** were discounted at the same rate (4%) as compliance cost estimates – another controversial approach

# Respirable crystalline silica

Exposure occurs in many industries, in particular

- Earth moving (mining, tunnelling, quarrying)
- Construction
- Manufacture of glass and other non-metallic products
- Foundries

~ 5,3m workers exposed in the EU (~4m in construction)

Weighted GM: 0.07 mg/m<sup>3</sup> (GSD: 5.2)

Time trend -7% per year

IARC Class 1 carcinogen (lung cancer)

RRs from literature review:

- Construction, pottery: 1.32
- Mining and other selected industries: 1.17

# RCS – health impact interventions

OEL: 0.05, 0.1 or 0.2 mg/m<sup>3</sup>

% workers at exposed levels > proposed OEL:

63%, 48% and 32%

Impact of introduction of OELs up to 2070

	Proposed OEL (mg/m <sup>3</sup> )			
	No OEL	0.05	0.1	0.2
Lung cancer registrations	5,800	350	840	1,700
Lung cancer deaths	5,700	340	820	1,800
YLLs	72,000	4,200	10,000	21,000
DALYs	73,000	4,400	11,000	22,000
Health benefit up to 2070	-	€28 -74bn	€26-68bn	€21-56bn
Cost of compliance up to 2070	-	€34bn	€19bn	€10bn

# Diesel Engine Exhaust - Exposure

Combustion of diesel fuel in compression ignition engines:

- Traffic
- Diesel powered heavy equipment

Complex mixture gases, particulate matter

Estimated 3.6m exposed workers in EU

Highest exposure in Mining, Construction, Transport

Overall GM in EU  $13 \mu\text{g}/\text{m}^3$  (GSD 2.7)

- based on Pronk et al (2009)

Estimated time trend:  $\sim -7\%$

# DEE – health impact no intervention

IARC Class I

Predicted attributable registrations and deaths in 2060

- Lung cancer: 2,643 cases; 2,594 deaths
- Bladder: 415 cases; 168 deaths

Intervention:

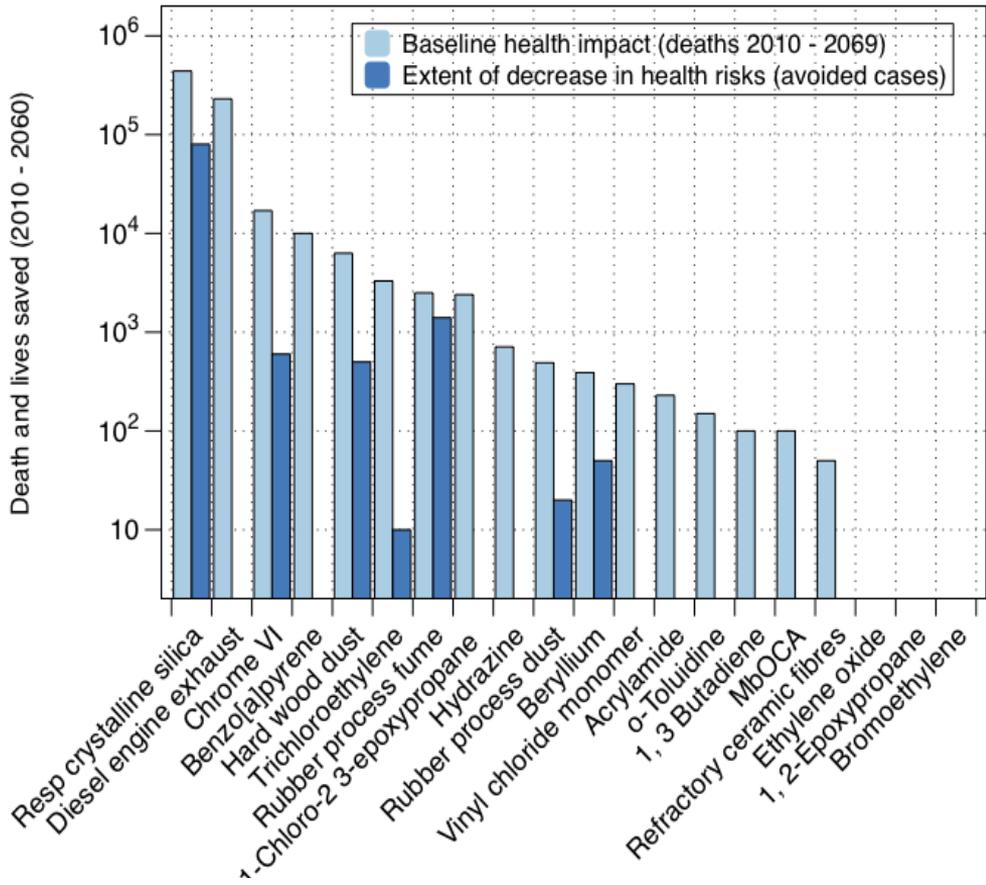
- introduction of OEL at  $100 \mu\text{g}/\text{m}^3$

No reduction in attributable cases and deaths

- currently levels are in most industries below  $100 \mu\text{g}/\text{m}^3$  already
- Except underground mining

To reduce impact, DEE exposure will need to be reduced further

# Lives Saved



Substance or mixture	OEL	Total compliance costs (€m)	Benefit to cost ratio
Chrome VI	0.1 mg/m <sup>3</sup>	€9,000 - €37,000	0.001
	0.05 mg/m <sup>3</sup>	€18,000 - €67,000	0.016
	0.025 mg/m <sup>3</sup>	€30,000 - €115,000	0.012
Respirable crystalline silica	0.2 mg/m <sup>3</sup>	€ 10,000	3.8
	0.1 mg/m <sup>3</sup>	€ 19,000	2.5
	0.05 mg/m <sup>3</sup>	€ 34,000	1.5
Beryllium and beryllium compounds	0.002 mg/m <sup>3</sup>	€18,000 - €34,000	0.011
4,4'-methylenedianiline (MDA)	0.8 mg/m <sup>3</sup>	€1,400 - €29,000	-
	0.08 mg/m <sup>3</sup>	€1,400 - €29,000	-
Hard wood dust	3 mg/m <sup>3</sup>	€ 0	-
	1 mg/m <sup>3</sup>	€3,800 - €8,600	0.029
Rubber process fume and dust	6mg/m <sup>3</sup> (dust)	€55 - €280	0.2
	0.6 mg/m <sup>3</sup> (fume)	€470 - €3,200	0.49
4,4'-Methylene bis 2-chloroaniline (MbOCA)	15µmol/mol	€560 - €1,100	0.005
	5µmol/mol	€1,500 - €3,000	0.003
Refractory ceramic fibres	1 f/ml	€ 0	-
	0.1 f/ml	€60 - €2,500	0.001
Mineral oils as used engine oil	NA	€46 - €920	-
Trichloroethylene	273 mg/m <sup>3</sup>	€61	0
	50 mg/m <sup>3</sup>	€428	0.64
Diesel engine exhaust emissions	0.1 mg/m <sup>3</sup>	€25 - €250	0
Hydrazine	0.13 mg/m <sup>3</sup>	€15 - €47	0
	0.013 mg/m <sup>3</sup>	€62 - €200	0
Vinyl chloride monomer	7.67 mg/m <sup>3</sup>	€ 0	-
	5.11 mg/m <sup>3</sup>	€3-€30	0
	2.56 mg/m <sup>3</sup>	€40 - €185	0.018
1, 3 Butadiene	11.4 mg/m <sup>3</sup>	€2 - €7	0
	2.28 mg/m <sup>3</sup>	€17 - €63	0
	1.14 mg/m <sup>3</sup>	€27 - €100	0
1, 2-Dichloroethane	20 mg/m <sup>3</sup>	€0 - €13	-
	4 mg/m <sup>3</sup>	€0 - €13	-

Zero compliance costs if exposure already < OEL

# Strength of evidence

Respirable crystalline silica  
Chrome VI  
Hardwood dust

Diesel engine exhaust  
Rubber fume  
Benzo[a]pyrene  
Trichloroethylene

Hydrazine  
Epichlorohydrin  
O-Toluidine  
Mineral oils as used engine oil

MDA

Strong case

Possible case

A limited case

Uncertainty

**For strong/possible:** Many had  
Sig<sup>n</sup> RRs  
Large nos. exposed  
Many exposed > OEL  
Inaction health costs high  
Often compliance costs high  
SMEs bear cost of compliance

# Conclusions

- Effort focused on the occupational carcinogens that contribute most to the health burden could contribute importantly towards the goal of eliminating occupational cancer
- Health impact assessment only included cancer, not other chronic diseases → hence, total health benefit from changes in OELs is underestimated
- Uncertainties include:
  - Varying amount and quality of available data
  - Assumptions about declining trends in exposure
  - Assumption of full compliance with limits
  - Valuing health effects – insufficient data on age during exposure, and willingness to pay estimates may be over or underestimates