Building understanding of the dangers of poor indoor air quality and actions to take or 'Plan B': seal the building and get a good filter

Camfil Farr Road Show: London 13 October 2011

Simon Birkett, Founder and Director,
Clean Air in London
www.cleanairinlondon.org
www.twitter.com/CleanAirLondon

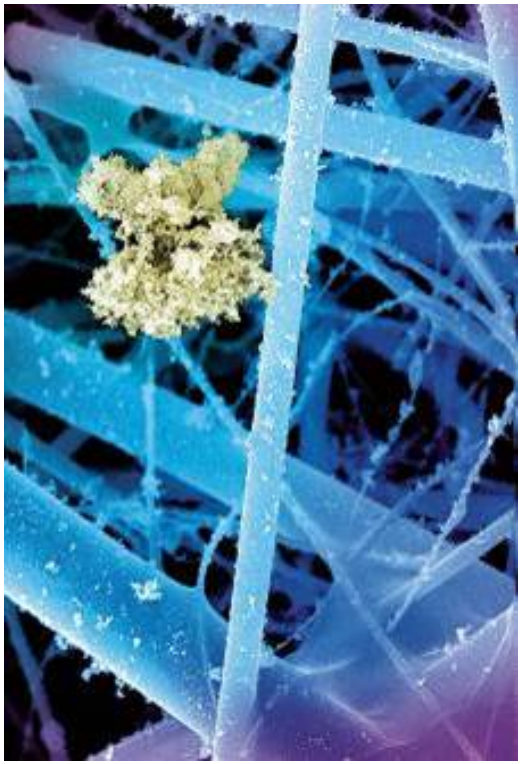
Camfil Farr Road Show and launch of campaign to build understanding of indoor air quality initially in London

- Welcome
- Presentations and questions
  - Indoor air quality
  - CityAir
- Lab stations
  - Why air filters are needed
  - How energy costs can be saved
  - Removing ozone gases
  - Visual performance demonstration
- Close

Summary

- Outdoor (or ambient) air quality is poor in cities
- Indoor sources (e.g. cooking) can make it worse inside
- Some of the basics: technical matters; relative size; and numbers, surface area and mass
- Health impacts: effects; exposures; sources; and costs
- Policy measures than could make a positive difference
- Current standards for air filters
- New campaign supported by Camfil Farr: let's start by asking one question

We can protect ourselves from 90% of air pollutants for up to 90% of the time



If your office has a mechanical ventilation system or air conditioning (i.e. it is likely to contain the necessary ducting) please ask your employer:

"Does our ventilation system include regularly maintained air filters that comply with European guideline EN 13779 and, if not, why not?"

Any questions: visit www.camfilfarr.co.uk or call 01706 238 000

Photo of soot particles in air filter

Photo: Lennart Nilsson

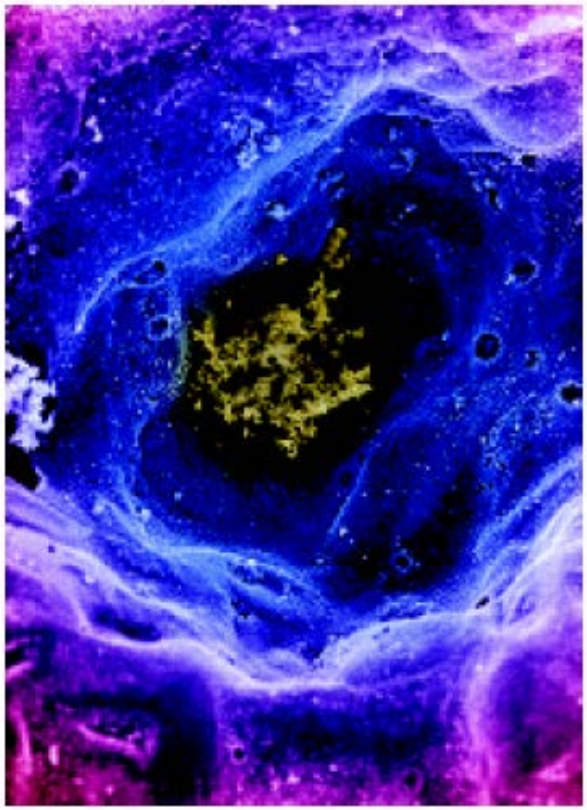
Ambient air quality

- Dangerous airborne particles ($PM_{2.5}$ and PM_{10}). Nitrogen dioxide (NO_2). Ozone (O_3). Diesel is a particular problem
- Twice WHO guideline levels for NO_2 and PM_{10}
- Around PM_{10} legal limit but twice NO_2 legal limit in London
- 'Pure' number: 4,267 attributable deaths; average 11.5 years
- More likely: all 15,800 cardiovascular deaths; average 3 years
- 1,148 schools near roads carrying over 10,000 vehicles per day
- NO_2 is <u>not</u> just a molecule: it's easily measured and strongly correlated with other toxic combustion gases
- 'Year of Air' in 2013: we need continuity and the further tightening of health and legal protections for air quality

Indoor air quality: Some key facts

- European citizens spend on average over 90% of their time indoors
- 75% or more of the health impact of outdoor or ‘ambient’ air pollution can therefore occur indoors (Source: EnVIE 2010 p82)
- Indoor concentrations of some pollutants can be much higher than outdoor (e.g. 10 or 20 times higher in the case of formaldehyde)
- We can use air filters to protect ourselves from 90% of air pollutants for up to 90% of the time
- European standard EN 13779 specifies the required filter performance for good indoor air quality in non-residential buildings taking into consideration outdoor air quality
- Second hand smoke (ETS) is still an issue e.g. children in homes

Indoor air quality: Some technical matters



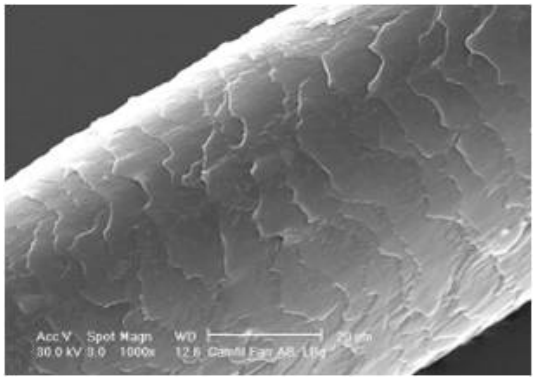
- Every day we eat about 1kg of food, drink 2-3kg (litres) and breathe around 20-30kg of air
- Particles and gases
- Particle size 1,000 nm = 1 μ
- Particle mass concentration μg/m^3
- Particle numbers
- Particle number concentration
- Particle surface area
- Nanoparticles gradually cluster together

Photo of soot particles in lung tissue

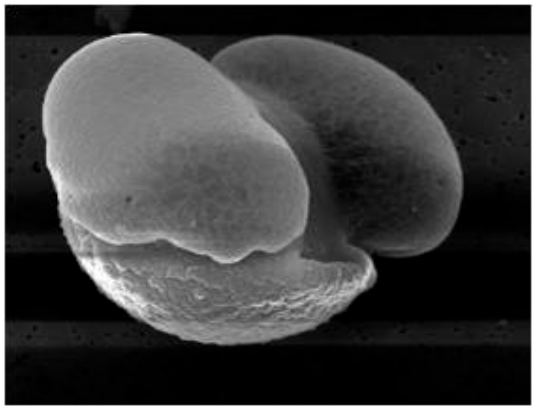
Photo: Lennart Nilsson

Indoor air quality: Relative size of particles

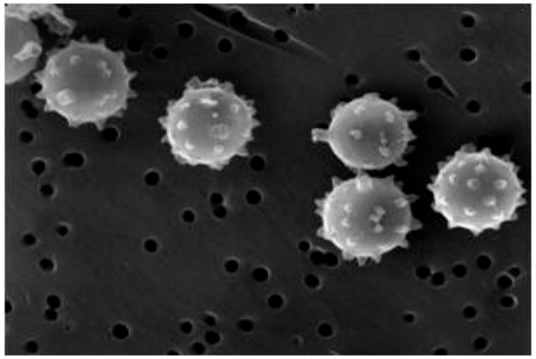
Human hair: 70 μm



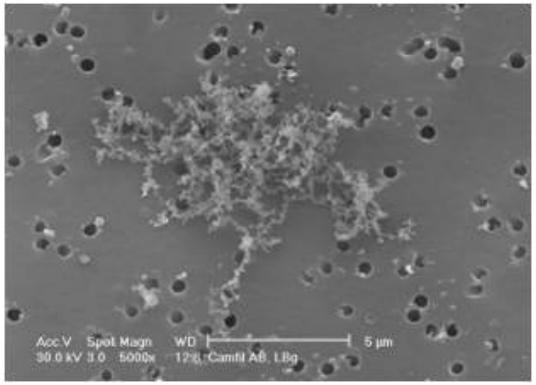
Pollen: 20-100 μm



Spores: 3-50 μm



Airborne particles: < 1 μm



Measurement of particle concentrations from different activities

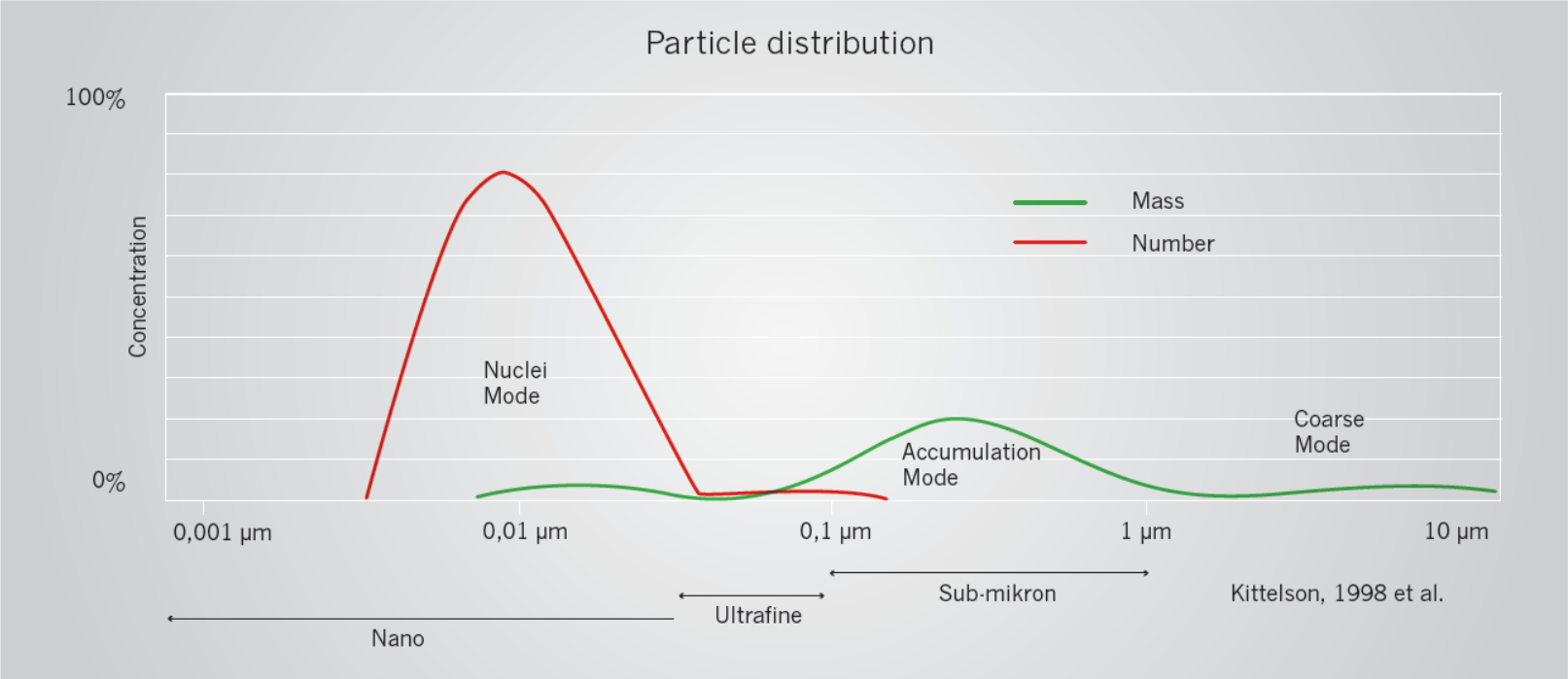
Particles with size between 20nm and about 1µm were measured at maximum concentration (number of particles per cubic centimeter) in a test chamber with ventilation corresponding to a 14 m² room with 1.7 air changes per hour i.e. about 3 times the normal standard

Iron with steam on cotton sheets	7 200
Scent Spray	29 900
Scented candles	69 600
Candles (paraffin)	241 500
Electric hot plate (fell after 6 min)	111 500
Radiator (dropped after 11 min)	218 400
Vacuuming with bag	21 400
Cigarette smoking	213 300
Frying mincemeat	150 900

Dice = 1 cm³

Källa: Socialstyrelsen - Partiklar i inomhusmiljön (2006)

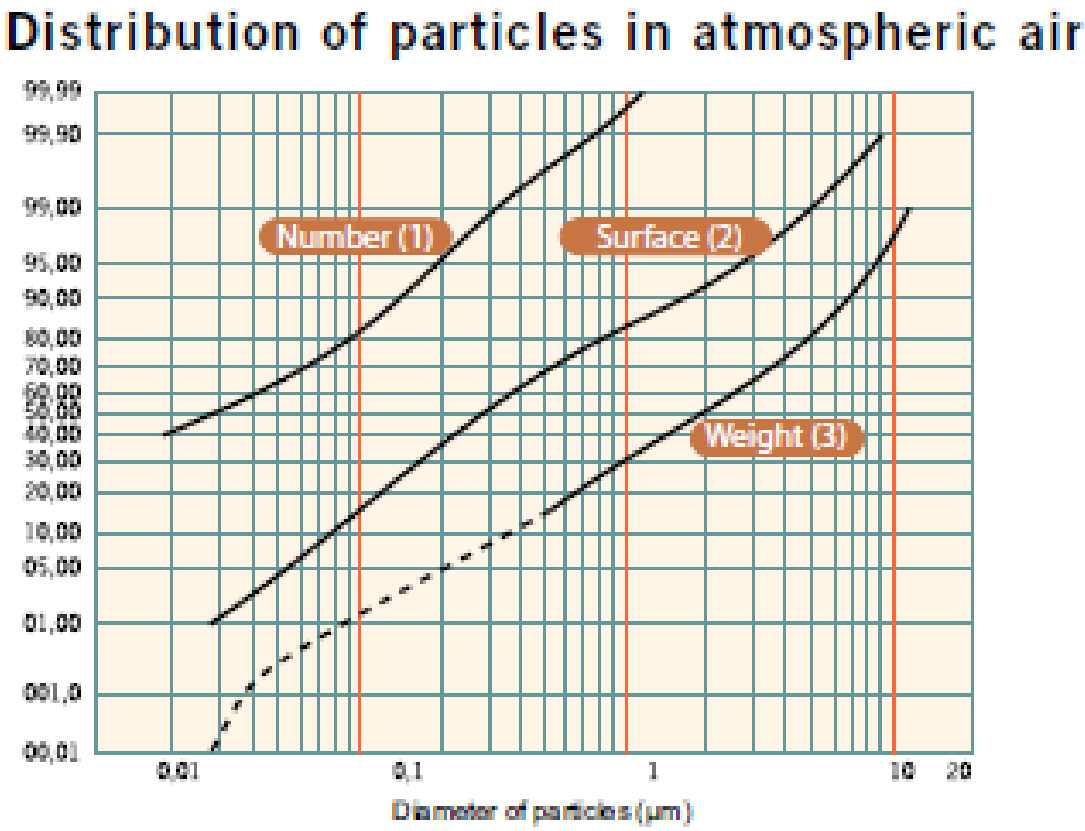
Typical engine exhaust mass and number weighted size distributions



If you brought together the mass of nanoparticles floating in the air around us, their area would be thousands of times greater than that of the heavier particles. The red graph shows that 99 per cent of the particles in the environment are nanoparticles. Those around 2,5µm and larger are few in number but weigh more. The nanoparticles gradually clusters together and form larger particles.

Source: D.B. Kittleson et al 2001

Whitby diagram: up to 99% of ambient airborne particles (by number and surface area) are less than 5μm in diameter



Comparing ambient and indoor air quality

Table 2. Typical and high end levels of some indoor air contaminants and the contributions of the indoor sources to both the typical and the high end indoor air exposure levels in Europe, and comparison to WHO (I)AQ Guidelines (WHO 2000 and 2006a).

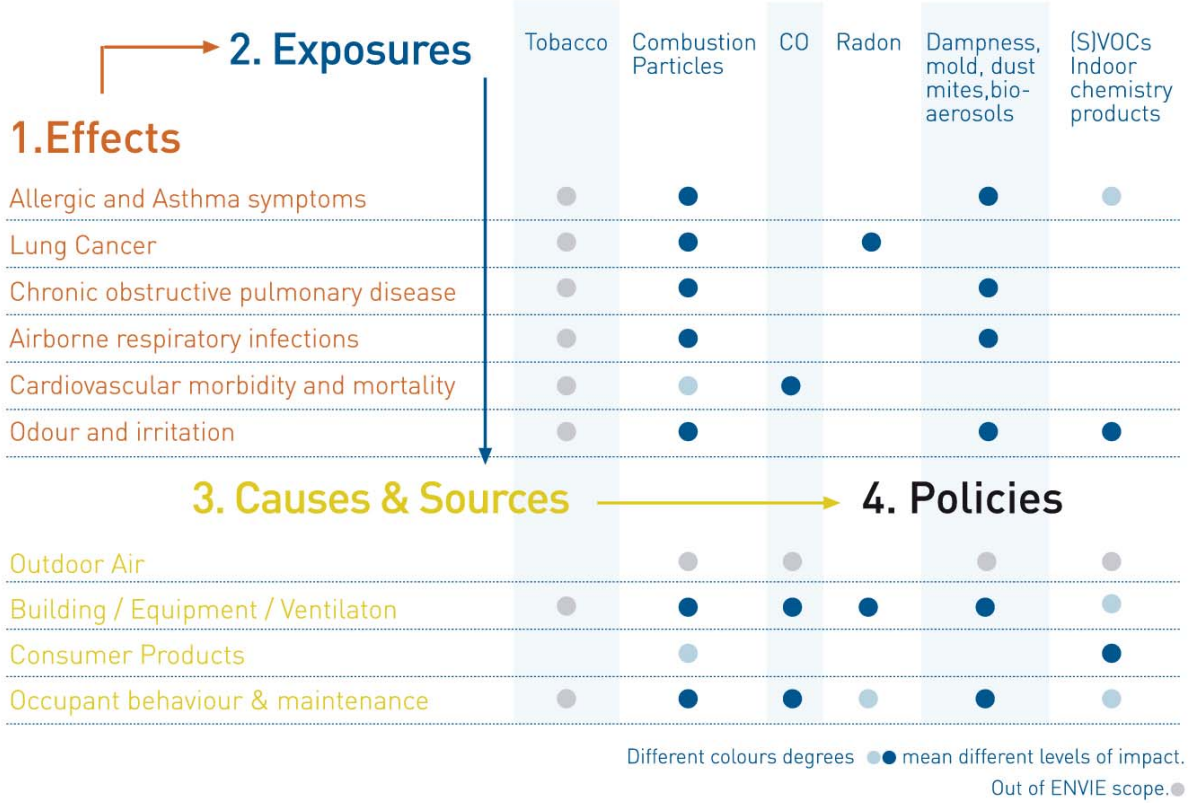
Agent	Long term (I)AQG (µg/m³)	Typical (µg/m³)	Indoor source (%)	High end (µg/m³)	Indoor source (%)
PM2.5 (PM10/2)	10	10 – 40	.. 30	100 – 300	> 90
CO (*	10	1 – 4	0	100 – 200	> 99
NO2	40	10 – 50	.. 20	100 – 200	> 75
Formaldehyde	30 (**	20 – 80	> 90	200 – 800	> 99
Benzene	5	2 – 15	.. 40	- 50	> 75
Naphthalene	10	1 – 3	.. 30	- 1000	> 99.9
Radon (Bq/m3)(***	200	20 – 100	> 90	- 100 000	> 99.9

Source: Promoting actions for healthy indoor air (IAIAQ) 2011

EnVIE project (2003-2008) published in 2010

- 55 month project co-funded by the European Commission
- The aim of the EnVIE project was to increase the understanding of the Europe-wide public health impacts of indoor air quality by identifying the most widespread and significant indoor causes for these health impacts and evaluating the existing and optional building and housing related policies for controlling them
- It addressed in particular how indoor air quality might contribute to the observed rise in asthma and respiratory allergy, together with other acute and chronic health impacts
- Small scale extension and update titled ‘Promoting actions for healthy indoor air’ (IAIAQ) in 2011

EnVIE method



Explanatory note: Different degrees of colours mean different levels of impact and/or out of the scope in EnVIE. Tobacco smoke is not addressed here because of the recent bans and even more because, if considered it will tend to hide all other impacts. Outdoor air was not object of EnVIE because it is covered by actual existent European air quality policies that control urban outdoor air concentrations.

Nine stressors assessed in six European countries

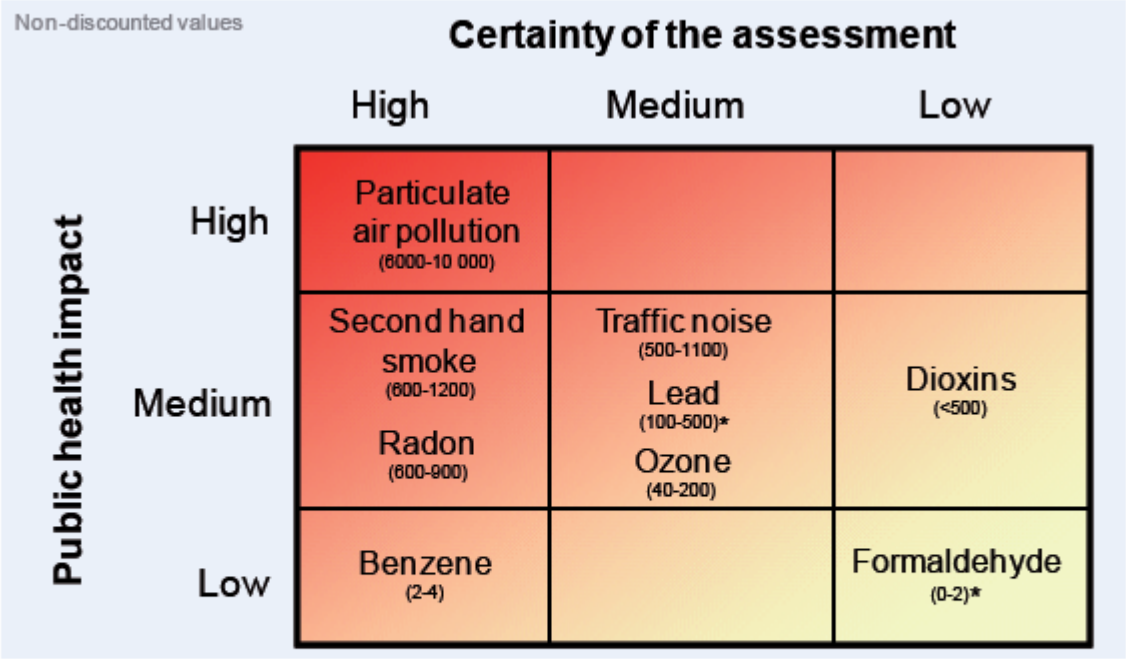


FIGURE 4-1. Relative public health impact of the selected environmental stressors in undiscounted un-ageweighted DALYs per population of a million in the participating countries. Numerical ranges reflect quantitative uncertainty in the average estimate. Variability between countries is in many cases much larger. (* =numerical model used in estimating threshold exceedances).

Source: European Perspectives on Environmental Burden of Disease (2011)

What is a DALY?

The **disability-adjusted life year (DALY)** is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death. Originally developed by the World Health Organisation it is becoming increasingly common in the field of public health and health impact assessment (HIA)

Effects: Contribution of ‘non-ideal’ IAQ to symptom and disease burden

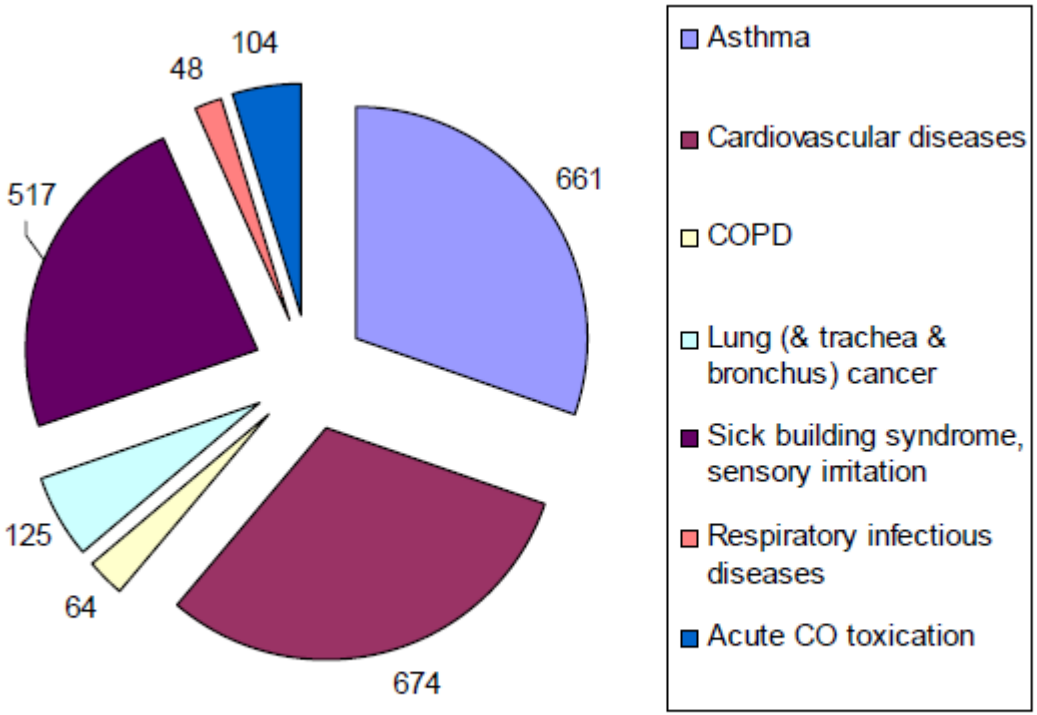


Figure 4. Contribution of non-ideal IAQ to symptom and disease burden in Europe, DALYs per year (thousands). ETS is not included.

Source: EnVIE project 2010

Exposures: Contribution of indoor air exposures to symptom and disease burden

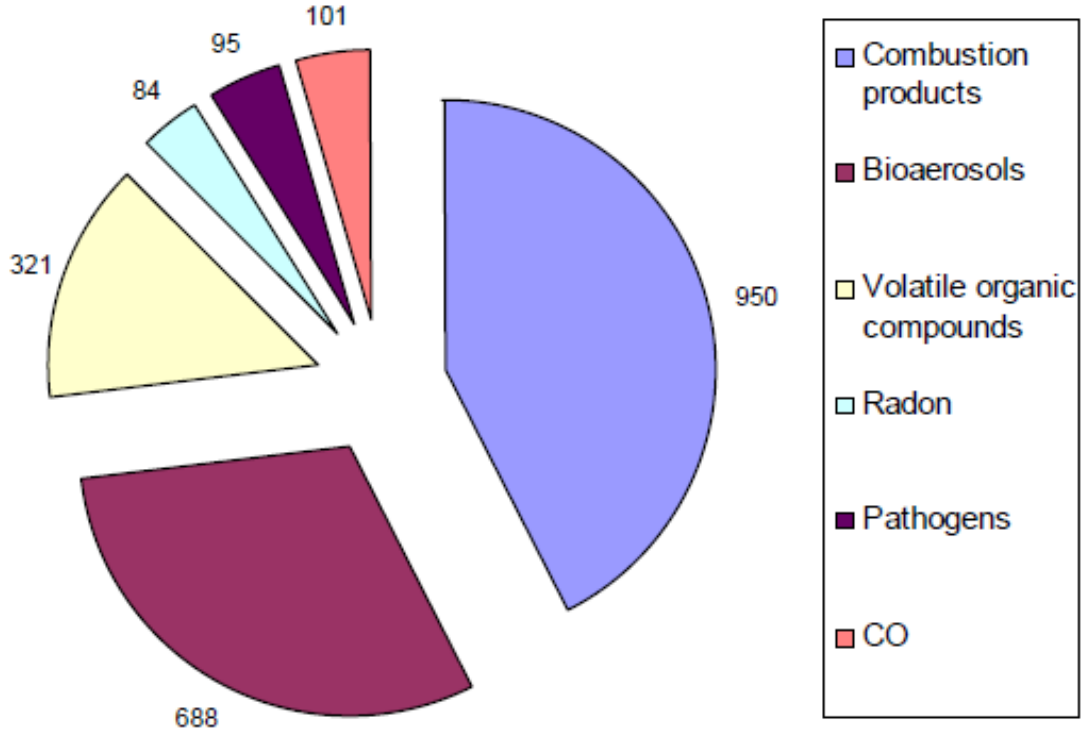


Figure 5. Contribution of indoor air exposures to symptom and disease burden in Europe, DALYs per year [thousands]. ETS is not included.

Source: EnVIE project 2010

Sources: Contribution of sources of indoor air pollution to symptom and disease burden

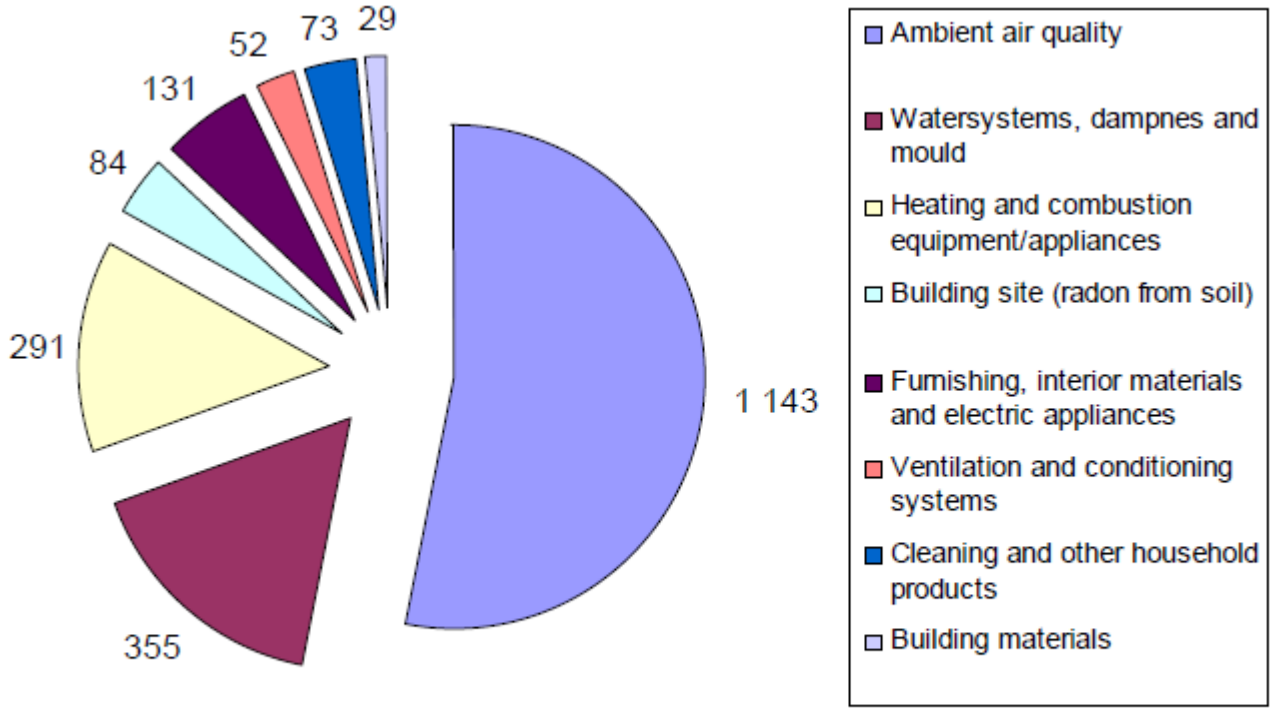
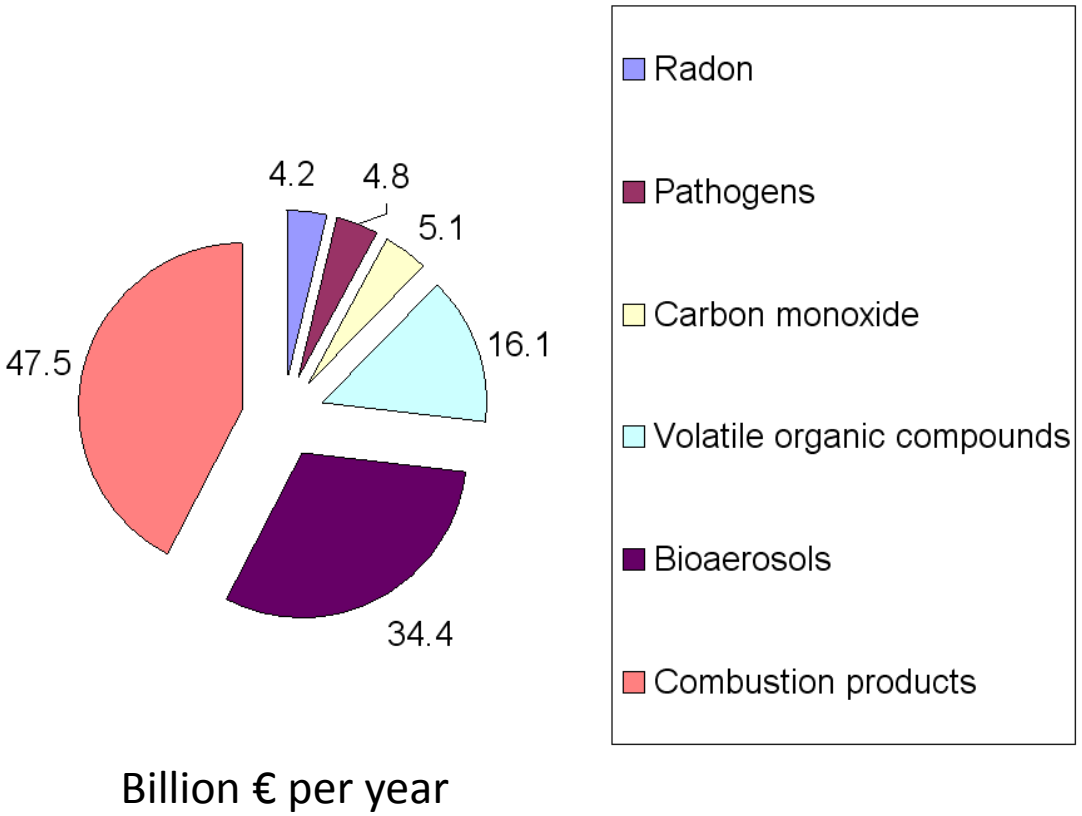


Figure 6. Contribution of the sources of indoor air pollution to symptom and disease burden in Europe, DALYs per year (thousands). ETS is not included.

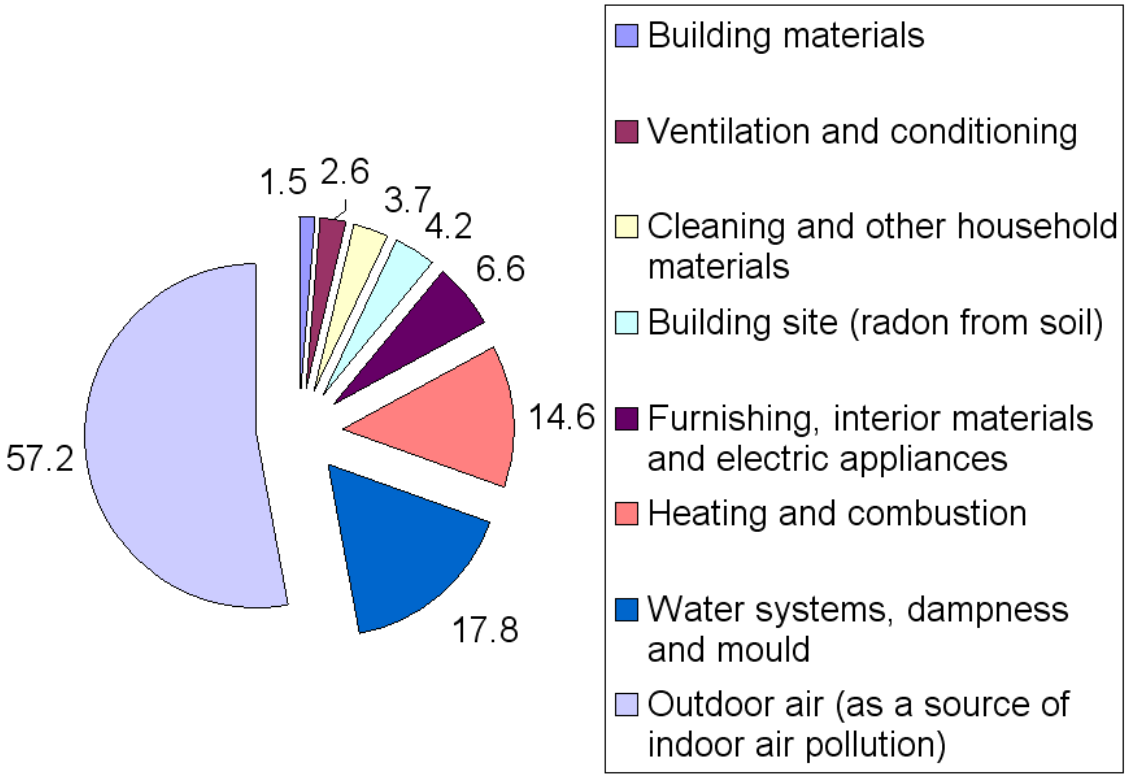
Source: EnVIE project 2010

Exposures: Cost impact of indoor air pollution



Source: Estimate provided by Gary Raw at 'Environmental Product Policy and IAQ' meeting in Brussels on 23-24 September 2010

Sources: Cost impact of indoor air pollution



Source: Estimate provided by Gary Raw at 'Environmental Product Policy and IAQ' meeting in Brussels on 23-24 September 2010

Effects: Contribution of 'non-ideal' IAQ to symptom and disease burden by country

Table 4. Contribution of non-ideal IAQ to symptom and disease burden in the European countries, DALYs [1] per year (thousands). ETS not included.

kDALY/year per country, diseases and symptom avoidable by ideal IAQ in Europe	Asthma	Cardiovascular diseases	COPD	Lung (& trachea & bronchus) cancer	Sick building syndrome, sensory irritation	Respiratory infectious diseases	Acute CO toxication
Belgium	12	10	2	3	12	1	2
Czech Republic	15	22	1,5	6	11	1	3
Denmark	5	5	1,4	1,3	6	0,3	3
Finland	7	3	0,2	1,3	6	0,6	0,9
France	96	55	8	19	67	6	5
Germany	90	88	9	18	86	8	22
Greece	7	19	0,9	3	12	1,1	3
Ireland	7	5	0,7	1,2	5	0,4	1,2
Italy	42	92	8	17	63	4	16
Netherlands	28	18	3	3	17	2	1,1
Poland	45	136	3	15	40	3	10
Portugal	21	16	2	2	11	2	1,1
Slovakia	5	12	0,3	2	6	0,6	1,5
Sweden	9	7	0,7	2	10	0,6	1,1
United Kingdom	138	56	9	7	64	7	9
Remaining EU-countries [2]	132	131	14	24	104	10	21
TOTAL	**661**	**674**	**64**	**125**	**517**	**48**	**101**

[1] DALY - Disability-Adjusted Life Year

[2] Austria, Bulgaria, Cyprus, Estonia, Hungary, Latvia, Lithuania, Luxembourg, Malta, Romania, Slovenia, Spain

Source: EnVIE project 2010

UK among worst three for:

- **Asthma**
- **COPD**
- Sick building syndrome
- Respiratory infectious diseases

Bold = UK worst in EU 27

Exposures: Contribution of indoor air exposures to symptom and disease burden

Table 5. Contribution of indoor air exposures to symptom and disease burden in the European countries, DALYs [1] per year (thousands). ETS is not included.

kDALY/year per country and exposure avoidable by ideal IAQ in Europe	Combustion products	Bio-aerosols	Volatile Organic Compounds	Radon	Pathogens	CO
Belgium	16	14	7	2	2	2
Czech Republic	28	15	8	5	2	3
Denmark	8	7	2	1	0,6	3
Finland	4	9	3	1,2	1,1	0,9
France	90	99	42	13	12	5
Germany	128	105	45	13	16	22
Greece	26	7	8	2	2	3
Ireland	7	7	3	1	0,9	1,2
Italy	126	37	47	12	7	16
Netherlands	31	31	6	1,3	3	1,1
Poland	164	45	22	7	7	10
Portugal	21	21	8	2	3	1,1
Slovakia	15	5	3	1,5	1,2	1,5
Sweden	11	10	6	2	1,2	1,1
United Kingdom	88	139	44	4	14	9
Remaining EU-countries [2]	186	137	65	16	21	21
TOTAL	**950**	**688**	**321**	**84**	**95**	**101**

[1] DALY - Disability-Adjusted Life Year

[2] Austria, Bulgaria, Cyprus, Estonia, Hungary, Latvia, Lithuania, Luxembourg, Malta, Romania, Slovenia, Spain

UK among worst three for:

- **Bio-aerosols**
- Volatile organic compounds
- Pathogens

Bold = UK worst in EU 27

Source: EnVIE project 2010

Sources: Contribution of sources of indoor air pollution to symptom and disease burden

Table 6. Contribution of the sources of indoor air pollution to symptom and disease burden in the European countries, DALYs [1] per year (thousands). ETS is not included.

kDALY/year per country and source avoidable by ideal IAQ in Europe	Ambient air quality	Water systems, dampness and mould	Heating and combustion equipment/ appliances	Building site (radon from soil)	Furnishing, decoration materials and electric appliances	Ventilation and conditioning systems	Cleaning and other household products	Building materials
Belgium	21	7	5	2	3	1,1	2	0,7
Czech Republic	31	8	8	5	3	1,2	2	0,7
Denmark	10	3	5	1	0,8	0,5	0,4	0,2
Finland	8	5	2	1,2	1,2	0,6	0,7	0,3
France	127	50	23	13	17	7	10	4
Germany	161	55	48	13	18	7	10	4
Greece	25	5	8	2	3	0,8	2	0,7
Ireland	10	3	3	1	1,4	0,5	0,8	0,3
Italy	125	20	41	12	19	4	11	4
Netherlands	40	16	7	1,3	3	2	1,5	0,6
Poland	153	24	43	7	9	4	5	2
Portugal	29	11	5	2	3	2	2	0,6
Slovakia	15	3	4	1,5	1,4	0,5	0,8	0,3
Sweden	15	5	3	2	3	0,8	1,4	0,6
United Kingdom	147	68	27	4	18	10	10	4
Remaining EU-countries [2]	226	72	58	16	27	10	15	6
TOTAL	**1143**	**355**	**291**	**84**	**131**	**52**	**73**	**29**

[1] DALY - Disability-Adjusted Life Year

[2] Austria, Bulgaria, Cyprus, Estonia, Hungary, Latvia, Lithuania, Luxembourg, Malta, Romania, Slovenia, Spain

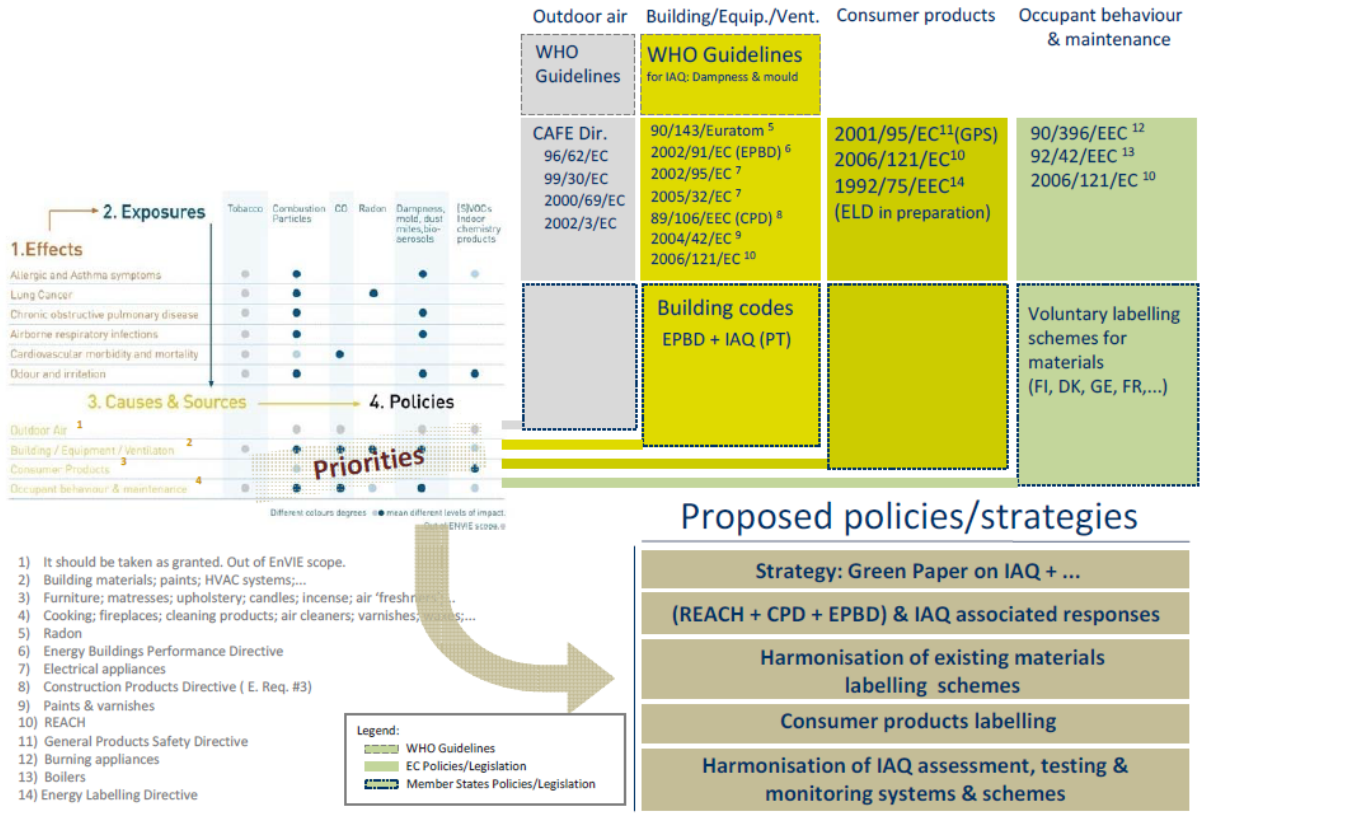
Source: EnVIE project 2010

UK among worst three for:

- Ambient air quality
- **Water systems, dampness and mould**
- Furnishing, decoration materials and electric appliances
- **Ventilation and conditioning systems**
- Cleaning and other household products
- **Building materials**

Bold = UK worst in EU 27

EnVIE policy assessment: The approach



This diagram is by no means exhaustive. It aims to illustrate the wide spectrum of policy tools (directives, guidelines,…), policy making levels (WHO, EU, member states, ..) and sour (outdoor air, building, consumer products,…). It also underlines the must strategic axes for policy making in the future.

Figure 3. Existing and proposed policies/legislation

Source: EnVIE project 2010

EnVIE policy assessment: New policies needed

- General policies e.g. build public understanding
- Building construction e.g. integrate IAQ into policies on urban development. Develop moisture control guidelines for buildings
- Ventilation e.g. regularly inspect and maintain all heating, ventilation and air conditioning (HVAC) systems. Include EN 13779 compliant air filters in HVAC systems. Ban all unflued combustion heaters. Integrate with energy performance inspections
- Consumer products e.g. testing and labelling of products
- Occupant behaviour and operation and maintenance e.g. best practice manuals for major buildings. Address further ETS

Source: EnVIE project 2010

EnVIE policy assessment: The detail

Table 2 Generalised table of the new policies needs to improve indoor air quality in buildings

Focus area	Policy or action	Type of action		
		Legislative actions	Standards and guidelines	Information
General policies	Disseminate information concerning IAQ and related risks and their prevention for general public and professionals.	To be mentioned in all legislative actions dealing with the built environment.		Use professional organisation and citizens organisations
	Develop European harmonised IAQ monitoring protocols and techniques to ensure comparability across Europe for the needs of surveys as well as compliance assessments	Recast EPBD related actions	CEN standards	Technical guidance documents for survey design, sampling and analyses
	Develop health surveys to verify the efficacy of the preventive measures. Define indoor exposure guidelines, in particular for dwellings and schools			
Building construction	Integrate IAQ in policies on urban development, regarding energy supply systems, and zoning. Because ambient air quality (AAQ) forms the basis for IAQ use energy supply that minimises ambient air pollution and plan and design for low energy buildings.	Sustainable urban planning		Guidelines of principles to administrators, planners and architects
	Develop and apply European harmonised protocols for IAQ testing, reporting and labelling for building materials, equipment and products.	REACH and CPD related actions	CEN standards	
	Develop European moisture control guidelines for building design, use and maintenance, to prevent persistent dampness and hidden and visible mould growth	CPD related actions European guidelines National building codes	CEN standards Design guidelines	
	Apply radon safe design and construction criteria for buildings in radon risk areas.	European guidelines National building codes	CEN standards	Design guidelines to professionals
Ventilation	Develop European health based ventilation guidelines to control exposure to pollutants and moisture from indoor and outdoor sources	European guidelines National building codes	CEN standards	Design guidelines to professionals
	Mandate regular inspection and maintenance for all ventilation and air conditioning systems (integrate with energy performance inspections)	Recast of EPBD related actions European guidelines National building codes	CEN standards	Guidelines or professionals
	Ban all unflued combustion heaters, equip gas stoves with exhaust hoods and fans, mandate CO detectors and regular maintenance/inspection for all combustion devices.	European directive	CEN standards Design guidelines	Design guidelines to professionals
Consumer products	Develop and apply European harmonised protocols for IAQ testing, for consumer products	GPSD related actions	CEN standards	
Occupant behaviour and Operation and maintenance	Provide systematic documentation and operating, inspection and maintenance manuals for major buildings and installations which may deteriorate IAQ or cause health risks		CEN standard	Guidelines or professionals
	Integrate IAQ knowledge, criteria nad values in all urban planning and building sustainable approach and performance assessment.			
	Develop policy and methods to integrate IAQ into the energy performance evaluation and audits of buildings	Recast EPBD	CEN standard	Guidelines or professionals
	Ban smoking in all indoor spaces under public jurisdiction	European directive		
	Develop policies to protecting children from ETS at home	European policy		Information campaign
	Develop information for pressure and action to encourage smoking bans in public housing and apartment buildings.			Information campaign

Source: EnVIE project 2010 p71

IAIAQ policy assessment: The opportunities

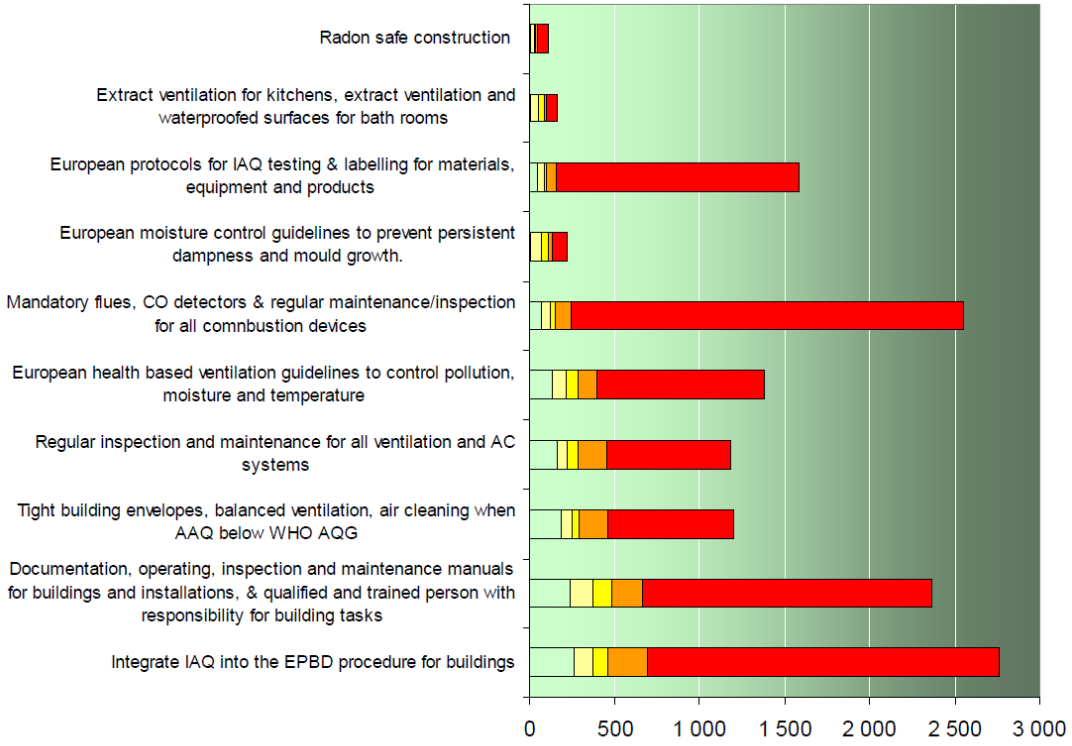
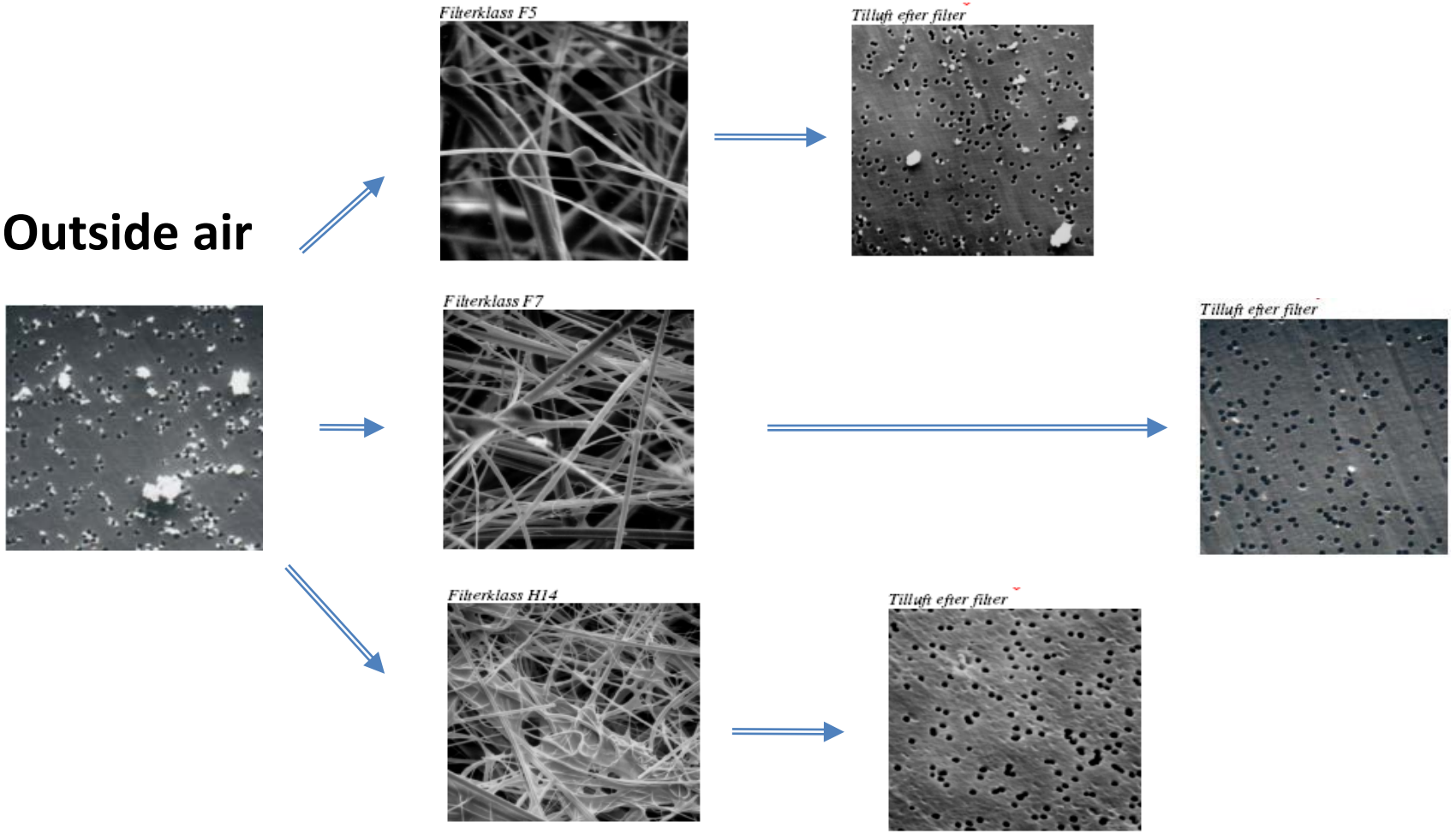


Figure 9. Distributions of the national public health benefit potentials of the 10 assessed policies in the 10th year of implementation (DALY/year*million) within the EU-26 countries. Levels from left to right: min – 1st quartile – median – third quartile – max.

Source: Promoting actions for healthy indoor air (IAIAQ) 2011

Particle filters of different efficiency



Source: Camfil Farr

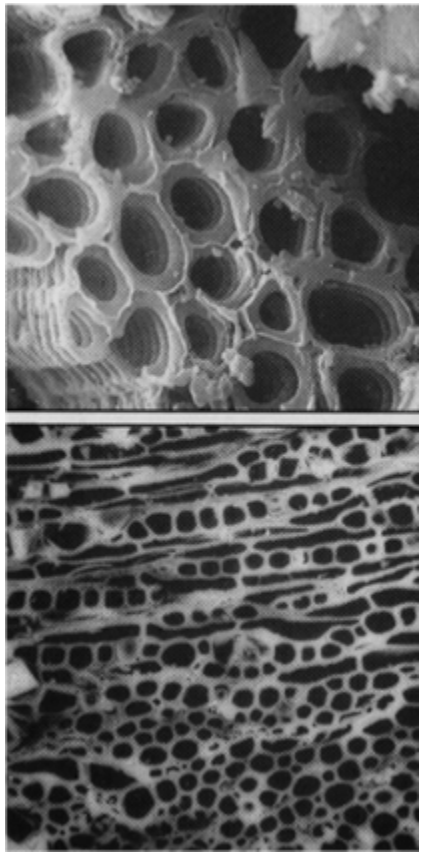
Air filter groups and classes

Group	Filter class	Example of use	Average collection efficiency for the most penetrating particle size (MPPS) %	Average efficiency for 0.4 μm particles %	Average arrestance of dust %
Coarse	G4	Warehouses			Over 90
Medium	M5	Protection of ventilation systems		40-59	
	M6			60-79	
Fine	F7	Schools		80-89 (min 35)	
	F8	Laboratories		90-94 (min 55)	
	F9	Healthcare		95 and above (min 70)	
Efficiency particulate filters	E10	Precision tooling	85		
	E11		95		
	E12		99.5		
High efficiency particulate filters	H13 and H14	Operating theatres	Over 99.95		
Ultra low penetration air filters	U15, U16 and U17	Space craft	Over 99.9995		

Gas filters – activated carbon/charcoal

Key issues include:

- **Charcoal's ability to retain gas molecules on their surface**
- **This capacity varies for different gases and charcoal quality**
- **Gas concentration**
- **Contact time**



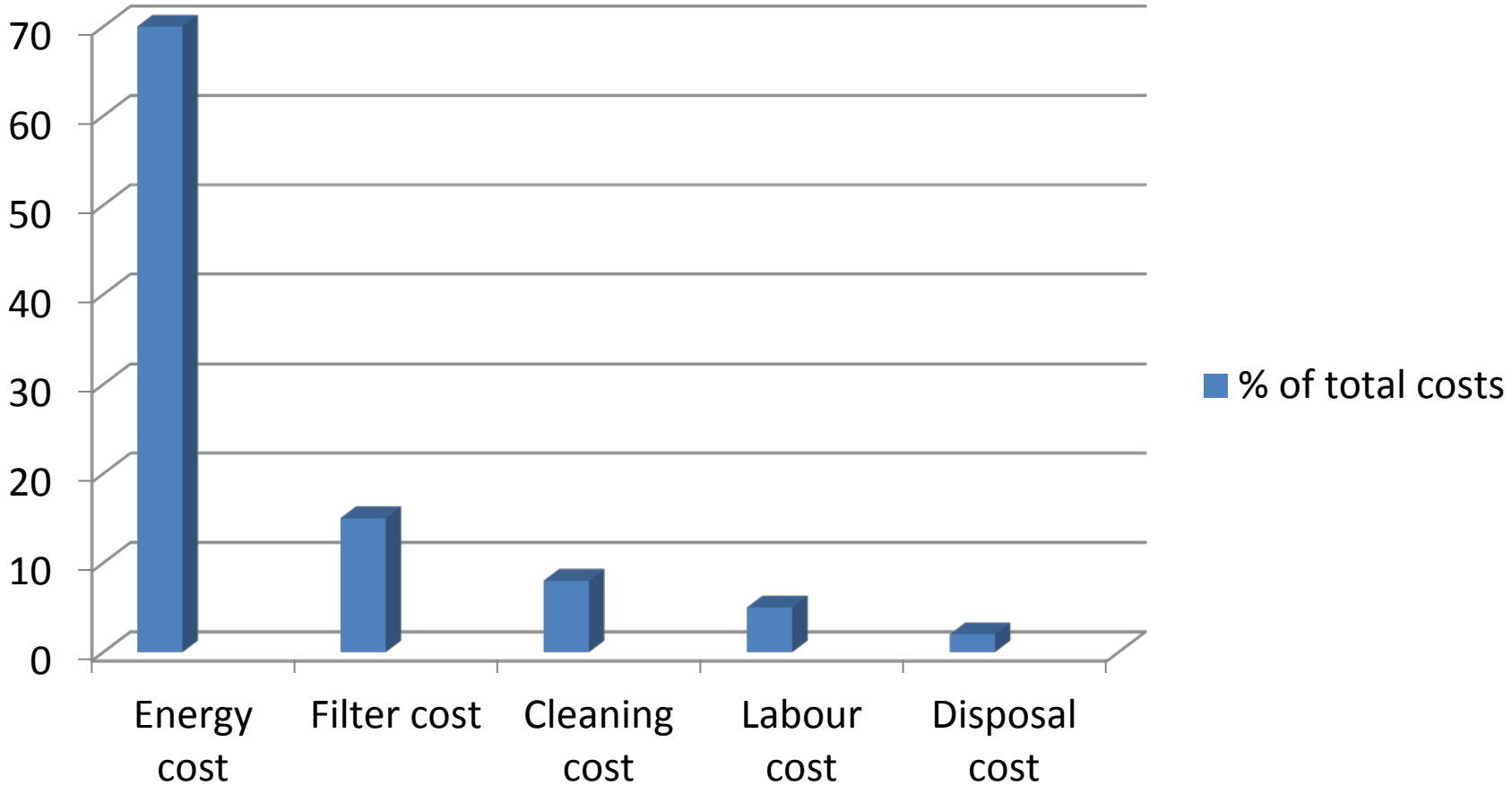
Source: Camfil Farr

European standard EN 13779 since April 2007 for non-residential buildings

Outdoor Air Quality (ODA)		Indoor Air Quality (IDA)			
		IDA 1 (High)	IDA 2 (Medium)	IDA 3 (Moderate)	IDA 4 (Low)
Increasing pollution ↓	ODA 1 eg countryside	F9	F8	F7	F5
	ODA 2 eg smaller towns	F7 + F9	F6 + F8	F5 + F7	F5 + F6
	ODA 3 eg city centres	F7 + GF + F9	F7 + GF + F9	F5 + F7	F5 + F6

GF = Gas filter (carbon filter) and/or chemical filter.
Table based on appendix A.3 “Use of air filters” in European standard EN 13779

Other benefits: Energy efficiency and cost savings



Source: Camfil Farr

Reminder: Health impacts of poor air quality

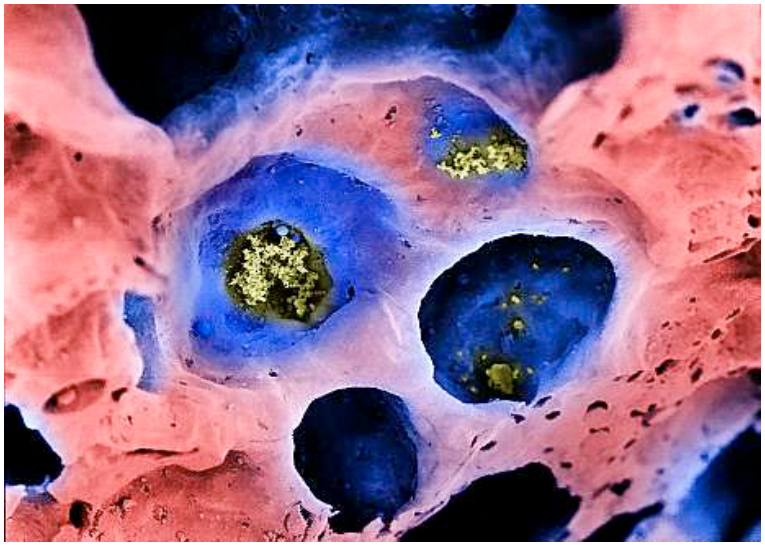
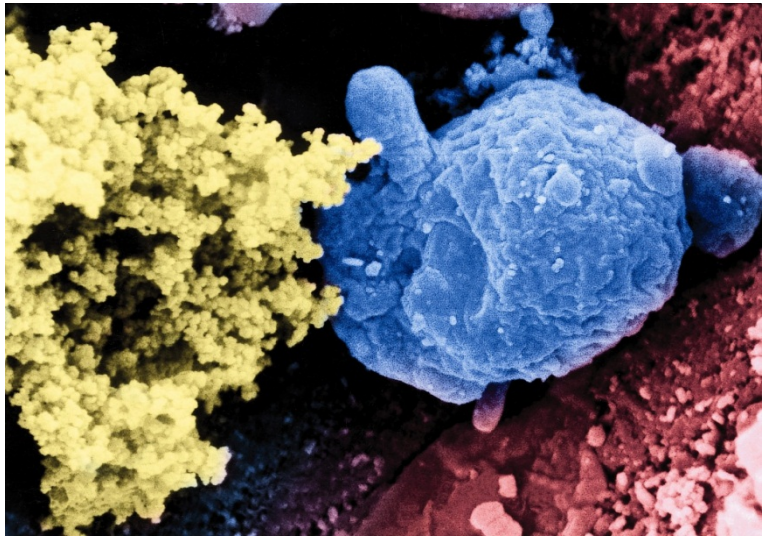


Photo of soot particles in lung tissue

Photo: Lennart Nilsson



A white blood corpuscle from the body's immune system (blue) tries to attack a soot particle and consume it

Photo: Lennart Nilsson

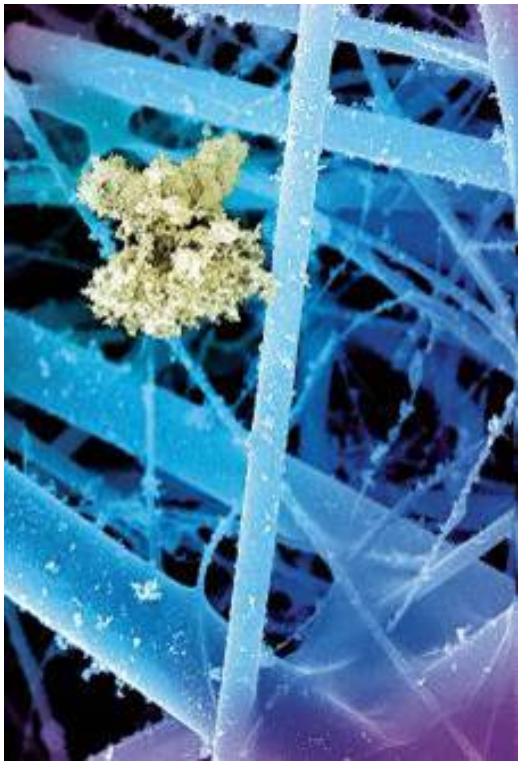
Reminder: Benefits of air filters

Photo: Lennart Nilsson

New campaign

- Campaign to build understanding of indoor air quality, initially in London. Launched today!
- We can protect ourselves from 90% of air pollutants for up to 90% of the time
- Ask one question: *"Does our ventilation system include regularly maintained air filters that comply with European guideline EN 13779 and, if not, why not?"*
- 'Year of Air' in 2013: seeking continuity and the further tightening of health and legal protections for ambient and indoor air quality
- Working with CityAir and others to communicate the need for action to address poor ambient and indoor air quality
- Willing to meet any of you to discuss action on poor air quality
- Camfil Farr Road Show due to return to London in w/c 21 May 2012

We can protect ourselves from 90% of air pollutants for up to 90% of the time



If your office has a mechanical ventilation system or air conditioning (i.e. it is likely to contain the necessary ducting) please ask your employer:

"Does our ventilation system include regularly maintained air filters that comply with European guideline EN 13779 and, if not, why not?"

Any questions: visit www.camfilfarr.co.uk or call 01706 238 000

Photo of soot particles in air filter

Photo: Lennart Nilsson

Summary

- Outdoor (or ambient) air quality is poor in cities
- Indoor sources (e.g. cooking) can make it worse inside
- Some of the basics: technical matters; relative size; and numbers, surface area and mass
- Health impacts: effects; exposures; sources; and costs
- Policy measures than could make a positive difference
- Current standards for air filters
- New campaign supported by Camfil Farr: let's start by asking one question

Building understanding of the dangers of poor indoor air quality and actions to take or 'Plan B': seal the building and get a good filter

Camfil Farr Road Show: London 13 October 2011

Simon Birkett, Founder and Director,
Clean Air in London
www.cleanairinlondon.org
www.twitter.com/CleanAirLondon

References

Camfil Farr
http://www.camfilfarr.co.uk/

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