Environmental Zones
The German Experience

Dr. Axel Friedrich

LOW EMISSION ZONES FOR TRANSPORT in the BENELUX?

BIVEC Seminar Leuven, 28th March 2012

EU limit values for PM10 and NO_2

averaging period	limit value	attainment period
24 h	50 µg/m^3 PM_{10}	1 Jan. 2005
	35 exceedances/year	
1 year	40 µg/m^3 PM_{10}	1 Jan. 2005
1 h	200 µg/m^3 NO_2	1 Jan. 2010
	18 exceedances/year	
1 year	40 µg/m^3 NO_2	1 Jan. 2010

PM 2.5 Limits of the EU- DIRECTIVE on ambient Air Quality and cleaner Air for Europe

LIMIT VALUE

Averaging period	Limit Value	Margin of tolerance	Date by which limit value is to be met
STAGE 1			
Calendar year	25 µg/m^3	20 % on …*, decreasing on the next 1 January and every 12 months thereafter by equal annual percentages to reach 0 % by 1 January 2015	1 January 2015
STAGE 2 (1)			
Calendar year	20 µg/m^3		1 January 2020
(1) Stage 2 - indicative limit value to be reviewed by the Commission in 2013 in the light of further information on health and environmental effects, technical feasibility and experience of the target value in Member States.			

* OJ: Date of entry into force of this Directive.

PM10 24h above the EU Limit in 2012

Messmethode: kontinuierlich (täglich aktualisiert, Stand: 23.3.2012)

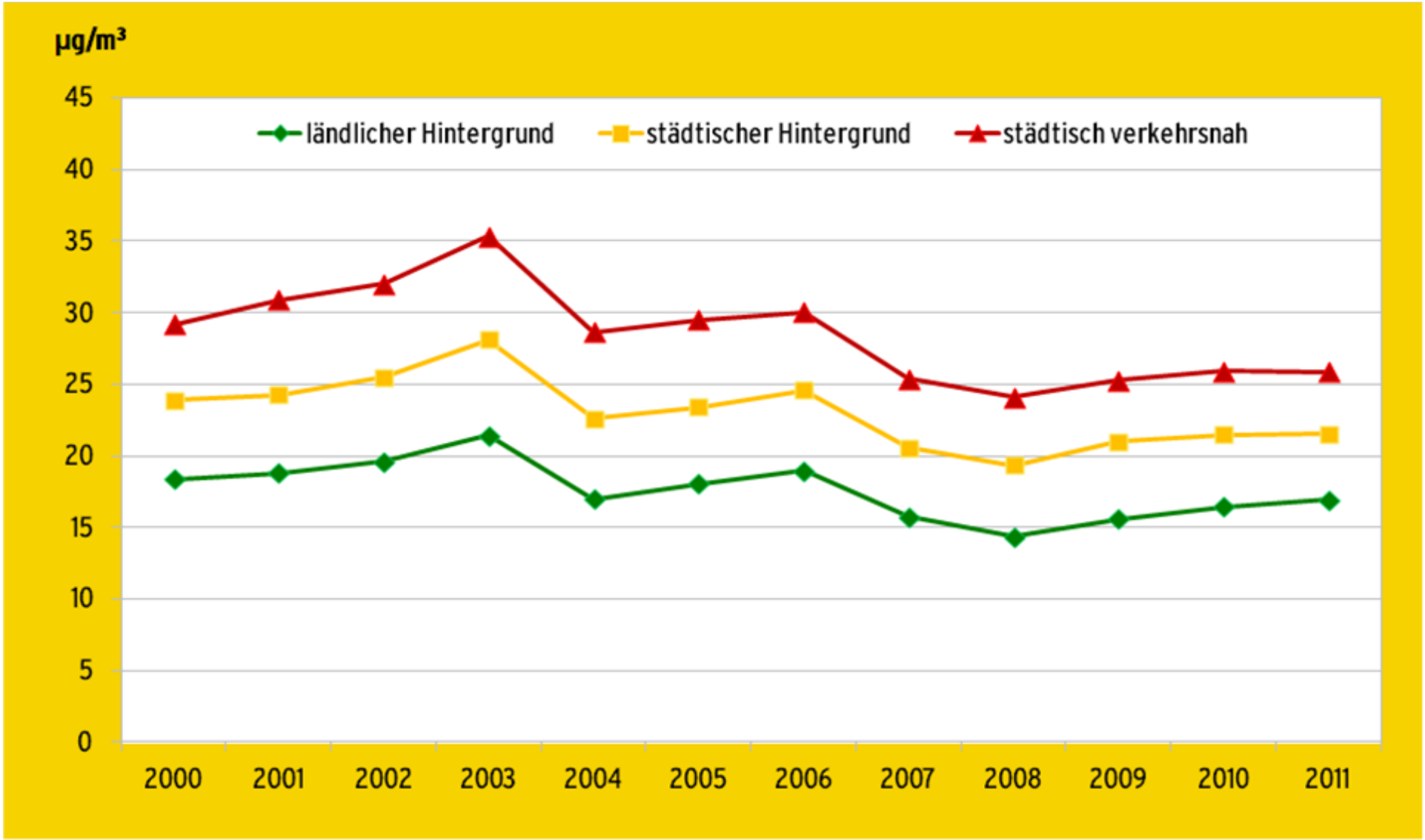
Station	Messnetz	Stationsname	Tage
DENW203	Nordrhein-Westf.	Herne Recklinghauser Straße	36
DENW208	Nordrhein-Westf.	Gelsenkirchen Kurt-Schumacher-Straße	35
DESN025	Sachsen	Leipzig-Mitte	29
DENW188	Nordrhein-Westf.	Oberhausen Mülheimer Straße 117	27
DESN077	Sachsen	Leipzig Lützner Str. 36	26
DEBY115	Bayern	München/Landshuter Allee	25
DENW134	Nordrhein-Westf.	Essen Gladbecker Straße	25
DENW133	Nordrhein-Westf.	Hagen Graf-von-Galen-Ring	25

Messmethode: gravimetrisch (monatlich aktualisiert)

Station	Messnetz	Stationsname	Tage	Zeitraum
DEBW118	Baden-Württ.	Stuttgart Am Neckartor (S)	27	1.1.2012 - 26.2.2012
DEBW142	Baden-Württ.	Markgröningen Grabenstraße (S)	20	1.1.2012 - 22.2.2012
DEBW147	Baden-Württ.	Reutlingen Lederstraße Ost (S)	20	1.1.2012 - 13.2.2012
DEBW136	Baden-Württ.	Tübingen Mühlstraße (S)	19	1.1.2012 - 13.2.2012
DEBW137	Baden-Württ.	Tübingen-Unterjesingen Jesinger Hauptstraße (S)	19	1.1.2012 - 27.2.2012
DEBW117	Baden-Württ.	Ludwigsburg Friedrichstraße (S)	18	1.1.2012 - 15.2.2012
DEBW150	Baden-Württ.	Murg Hauptstraße (S)	18	1.1.2012 - 23.2.2012
DENW102	Nordrhein-Westf.	Duisburg-Bruckhausen	16	1.1.2012 - 29.2.2012

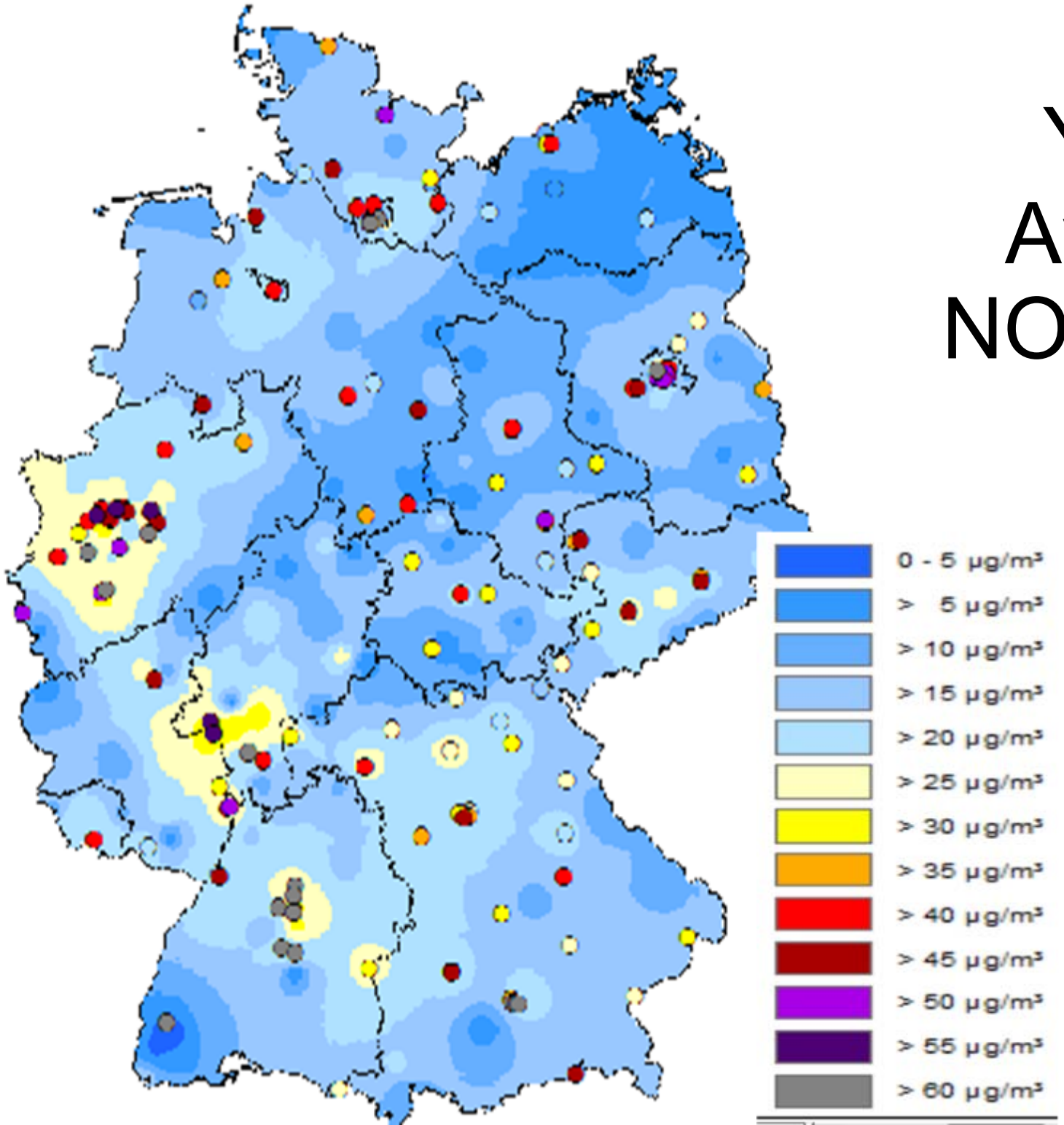
Development of the yearly Average pm_{10} Value

For the Stations „rural background“, „urban background“ and „urban near traffic“ between 2000 bis 2011



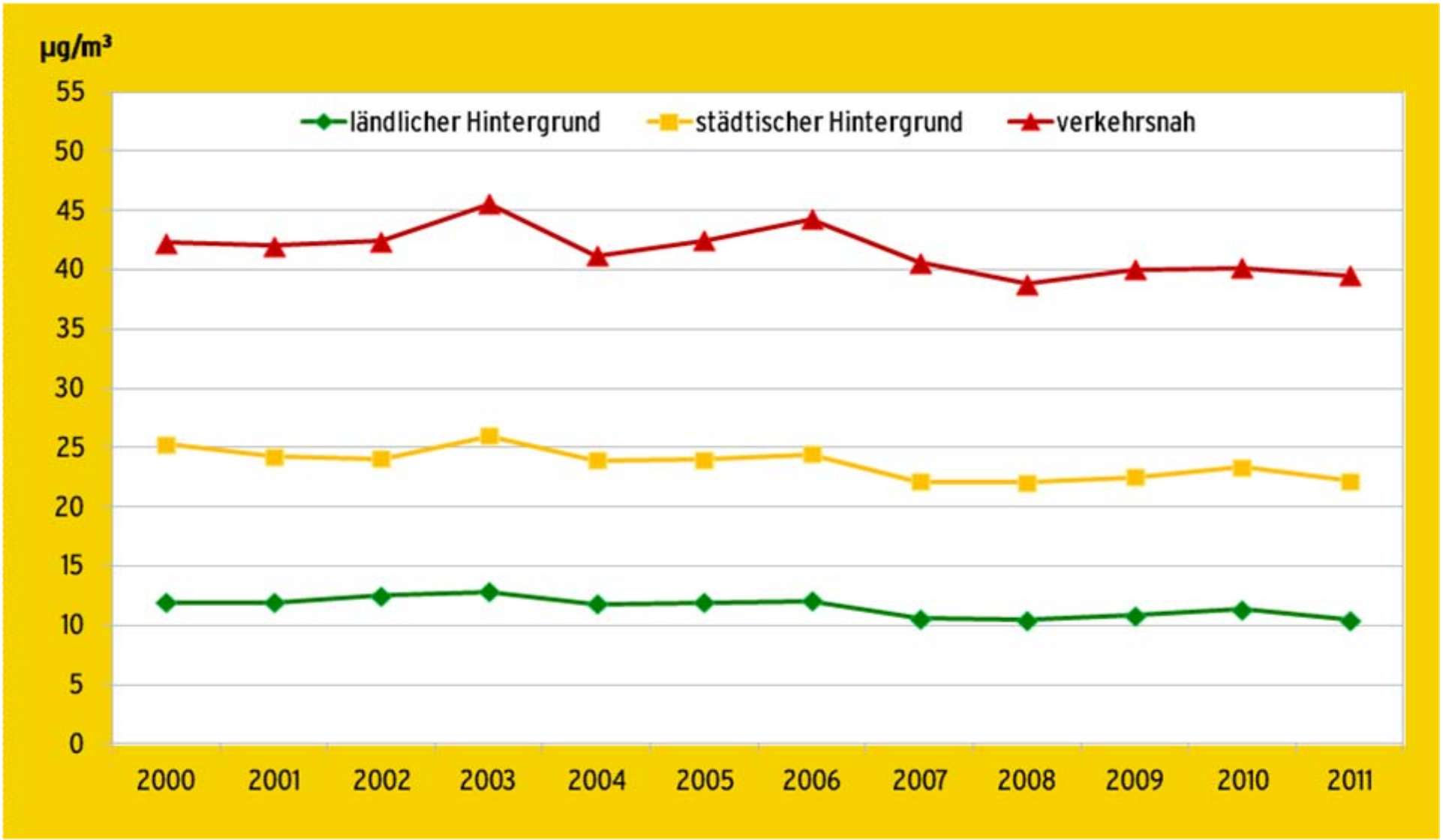
Source:UBA 2012

Yearly Average NO_2 Values 2011



Development of the yearlyAverage NO_2 Value

For the Stations „rural background“, „urban background“ and „urban near traffic“ between 2000 bis 2011



Source:UBA 2012

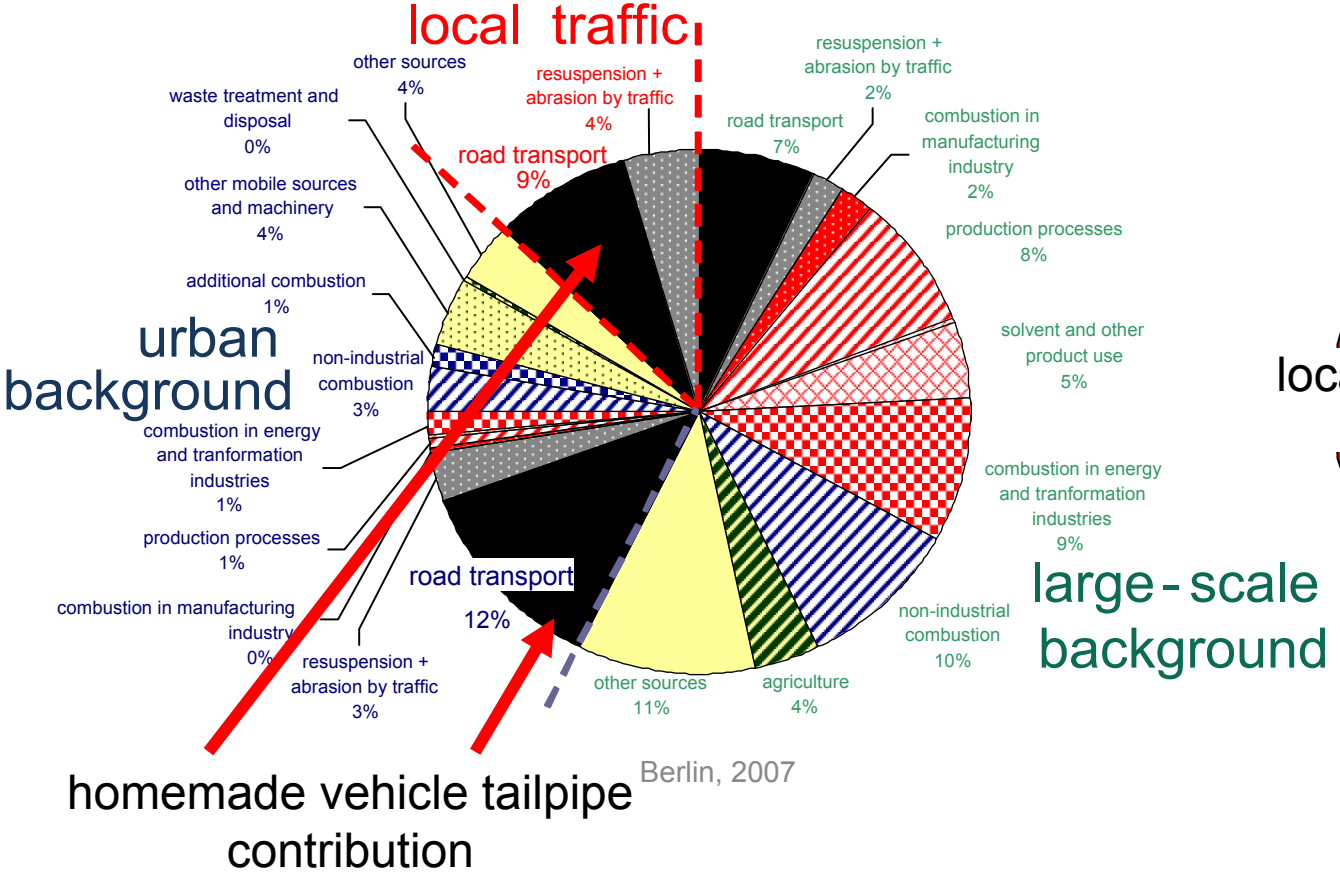
Measurement Stations with the highest NO_2 Values

Measurement Station	Typ of station	Yearly Av. in µg/m³	number of hourly values > 200 µg/m³
Stuttgart Hohenheimer Straße (S)	traffic	97	269
Stuttgart Am Neckartor (S)	traffic	90	76
München/Landshuter Allee	traffic	85	50
Reutlingen Lederstraße Ost (S)	traffic	84	43
München/Stachus	traffic	76	6
Tübingen Mühlstraße (S)	traffic	73	41
Köln Clevischer Ring 3	traffic	68	1
Freiburg Schwarzwaldstraße (V)	traffic	67	0
Hamburg Max-Brauer-Allee II (Straße)	traffic	67	4
Leonberg Grabenstraße (S)	traffic	66	8
B Hardenbergplatz	traffic	66	4
Stuttgart-Mitte-Straße (V)	traffic	65	6
Düsseldorf Corneliusstraße	traffic	64	2
Pleidelsheim Beihinger Straße (S)	traffic	63	22
Darmstadt-Hügelstraße	traffic	63	44
Ludwigsburg Friedrichstraße (S)	traffic	62	2
München/Prinzregentenstraße	traffic	61	7
Hamburg Habichtstraße	traffic	61	10

Umwelt Bundes Amt

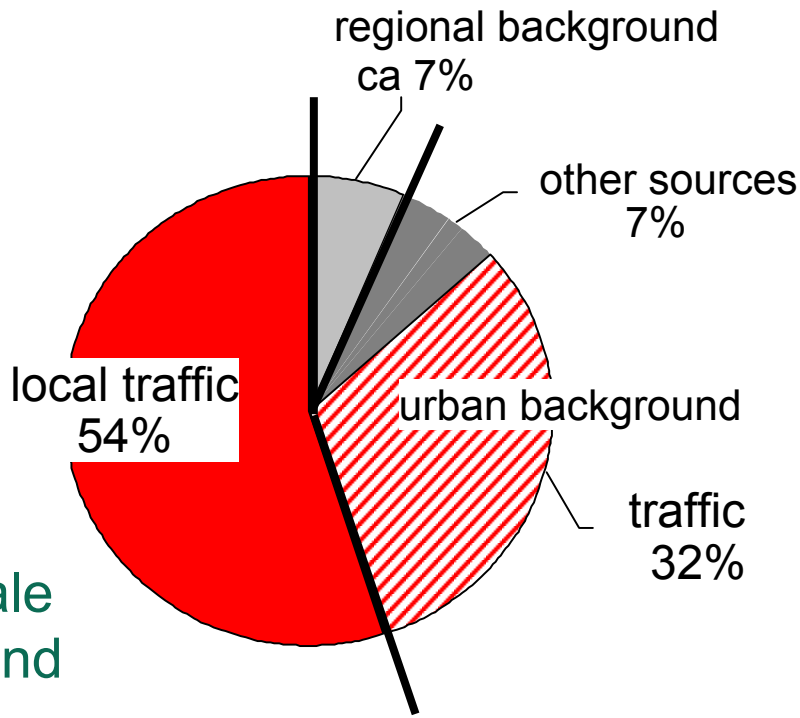
Origin of Kerbside PM2.5 and NO2 in Berlin

sources of roadside PM2.5 pollution



Berlin, 2007

sources of roadside NO2 pollution



Basis: NOx modelling

Environmental Zones

Key points for a Label Ordinance

according to § 40 Abs. 3 BImSchG (2)

P- Cars

- **Red Group**

PM > **50 mg/km** (Emission limits Euro 2)

- **Yellow Group**

PM < **50 mg/km**, (Emission limit Euro 3).This limit can also achieved by retrofit.

- **Green Group**

PM < 25 **mg/km** (Emission limit Euro 4)This limit can also achieved by retrofit.

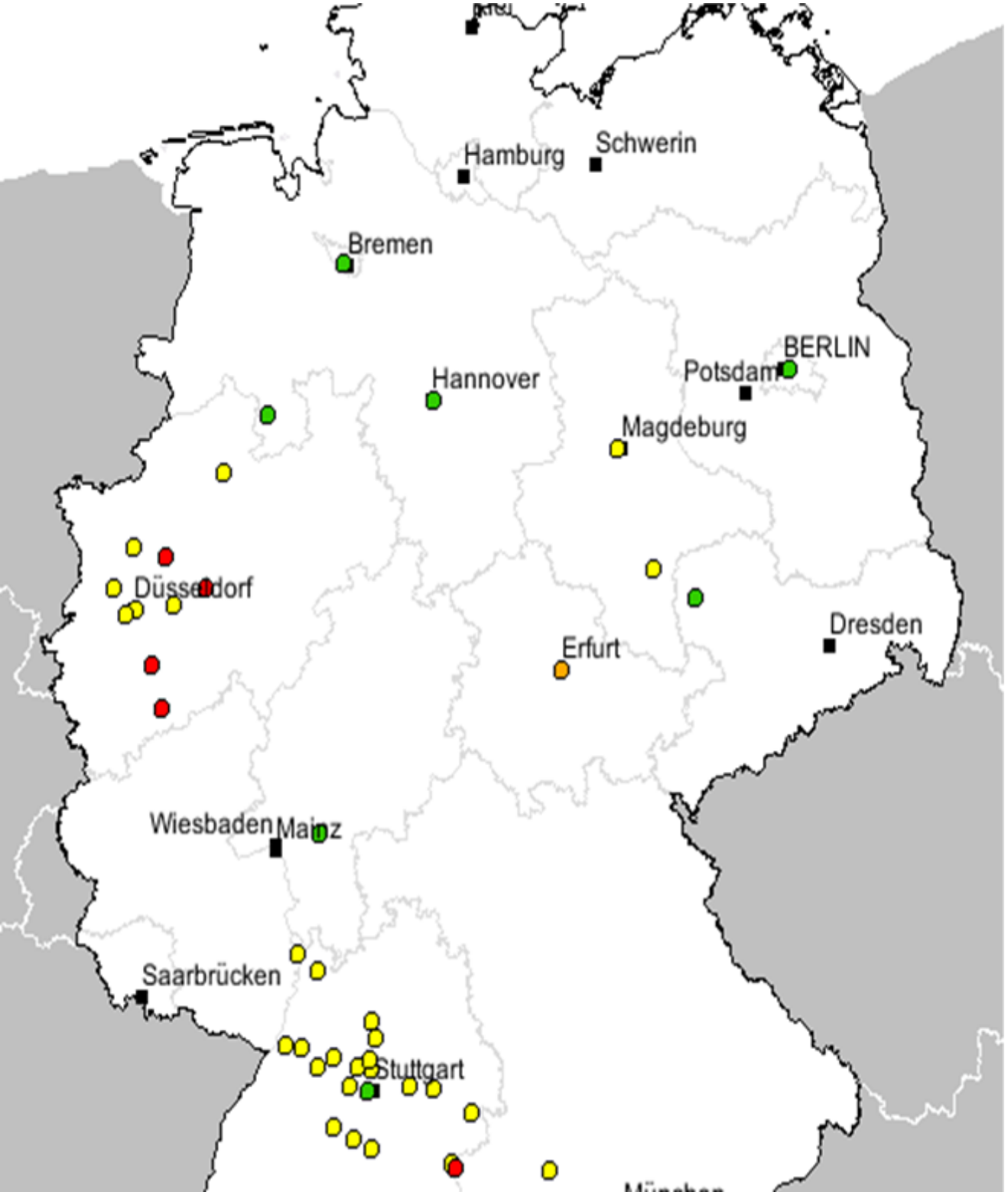
Emissions class	1	2	3	4
Sticker	No Sticker			
Requirement for diesel vehicles	Euro 1 or worse	Euro2 or Euro1 + particulate filter	Euro3 or Euro2 + particulate filter	Euro4 or Euro3 + particulate filter
Requirement for petrol vehicles	Without a catalytic converter			Euro1 with catalytic converter or better

The bottom of the sign indicates which vehicle sticker(s) are allowed to enter.
A sticker must be bought and displayed in the windscreen.

Penalty;

40 € fine and one point in the national traffic penalty register

Environmental Zones in Germany 2012



EZ planned

EZ only vehicles with a red,yellow or green sticker

EZ only vehicles with yellow or green sticker

EZ only vehicles with green sticker

Bundesland	Ort	Status	Stufe 1	Stufe 2	Stufe 3
Baden-Württemberg:	Freiburg	Stufe 2	01.01.2010	01.01.2012	01.01.2013
	Heidelberg	Stufe 2	01.01.2010	01.01.2012	01.01.2013
	Heidenheim	Stufe 2	01.01.2012	01.01.2012	01.01.2013
	Heilbronn	Stufe 2	01.01.2009	01.01.2012	01.01.2013
	Herrenberg	Stufe 2	01.01.2009	01.01.2012	01.01.2013
	Ilsfeld	Stufe 2	01.03.2008	01.01.2012	01.01.2013
	Karlsruhe	Stufe 2	01.01.2009	01.01.2012	01.01.2013
	Leonberg	Stufe 2	01.03.2008	01.01.2012	01.01.2013
	Ludwigsburg	Stufe 2	01.03.2008	01.01.2012	01.01.2013
	Mannheim	Stufe 2	01.03.2008	01.01.2012	01.01.2013
	Markgröningen	Stufe 2	01.07.2011	01.07.2011	01.01.2013
	Mühlacker	Stufe 2	01.01.2009	01.01.2012	01.01.2013
	Pfinztal	Stufe 2	01.01.2010	01.01.2012	01.01.2013
	Pforzheim	Stufe 2	01.01.2009	01.01.2012	01.01.2013
	Pleidelsheim-Ingersheim-Freiberg	Stufe 2	01.01.2012	01.01.2012	01.01.2013
	Tübingen	Stufe 2	01.03.2008	01.01.2012	01.01.2013
	Ulm	Stufe 2	01.01.2009	01.01.2012	01.01.2013
	Urbach	Stufe 2	01.01.2012	01.01.2012	01.01.2013
Bayern:	Augsburg	Stufe 2	01.07.2009	01.01.2011	01.01.2013
	München	Stufe 2	01.10.2008	01.10.2010	01.10.2012
	Neu-Ulm	Stufe 1	01.11.2009	keine Angabe	keine Angabe
Berlin:	Berlin	Stufe 3	01.01.2008	01.01.2010	01.01.2010
Bremen:	Bremen	Stufe 3	01.01.2009	01.01.2010	01.07.2011
Hessen:	Frankfurt a.M.	Stufe 3	01.10.2008	01.01.2010	01.01.2012

Bundesland	Ort	Status	Stufe 1	Stufe 2	Stufe 3
Niedersachsen:	Hannover	Stufe 3	01.01.2008	01.01.2009	01.01.2010
	Osnabrück	Stufe 3	04.01.2010	03.01.2011	03.01.2012
Nordrhein-Westfalen:	Bonn	Stufe 1	01.01.2010	keine Angabe	keine Angabe
	Dinslaken	Stufe 2	01.07.2011	01.07.2011	keine Angabe
	Düsseldorf	Stufe 2	15.02.2009	01.03.2011	keine Angabe
	Hagen	Stufe 1	01.01.2012	01.01.2013	01.07.2014
	Krefeld	Stufe 2	01.01.2011	01.01.2011	keine Angabe
	Münster	Stufe 2	01.01.2010	01.01.2010	keine Angabe
	Neuss	Stufe 2	15.02.2010	01.03.2011	keine Angabe
	Ruhrgebiet (Bochum, Bottrop, Castrop-Rauxel, Dortmund, Duisburg, Essen, Gelsenkirchen, Gladbeck, Herne, Herten, Mülheim, Oberhausen, Recklinghausen)	Stufe 1	01.01.2012	01.01.2013	01.07.2014
	Wuppertal	Stufe 2	15.02.2009	01.03.2011	keine Angabe
Sachsen:	Leipzig	Stufe 3	01.03.2011	01.03.2011	01.03.2011
Sachsen-Anhalt:	Halle (Saale)	Stufe 2	01.09.2011	01.09.2011	01.01.2013
	Magdeburg	Stufe 2	01.09.2011	01.09.2011	01.01.2013
Thüringen:	Erfurt	geplant	01.10.2012	01.10.2012	01.10.2012

Berlin Environmental Zone Emission Citeria

Stage 1: since 1.1.2008

- Diesel vehicles: at least Euro 2 or Euro 1 & retrofit
- Gasoline vehicles: at least Euro 1
- 7% of vehicle fleet affected

Stage 2: since 1.1.2010

- Diesel: Particle emission Euro 4:
- cars: Euro 3 + particle filter or better
- goods vehicles: also retrofit of Euro 1-3 towards Euro $4_{Particle}$
- 10% of the vehicle fleet affected

Area:

about 88 km²
(Berlin total area: 892 km²)

Inhabitants:

about 1 Million

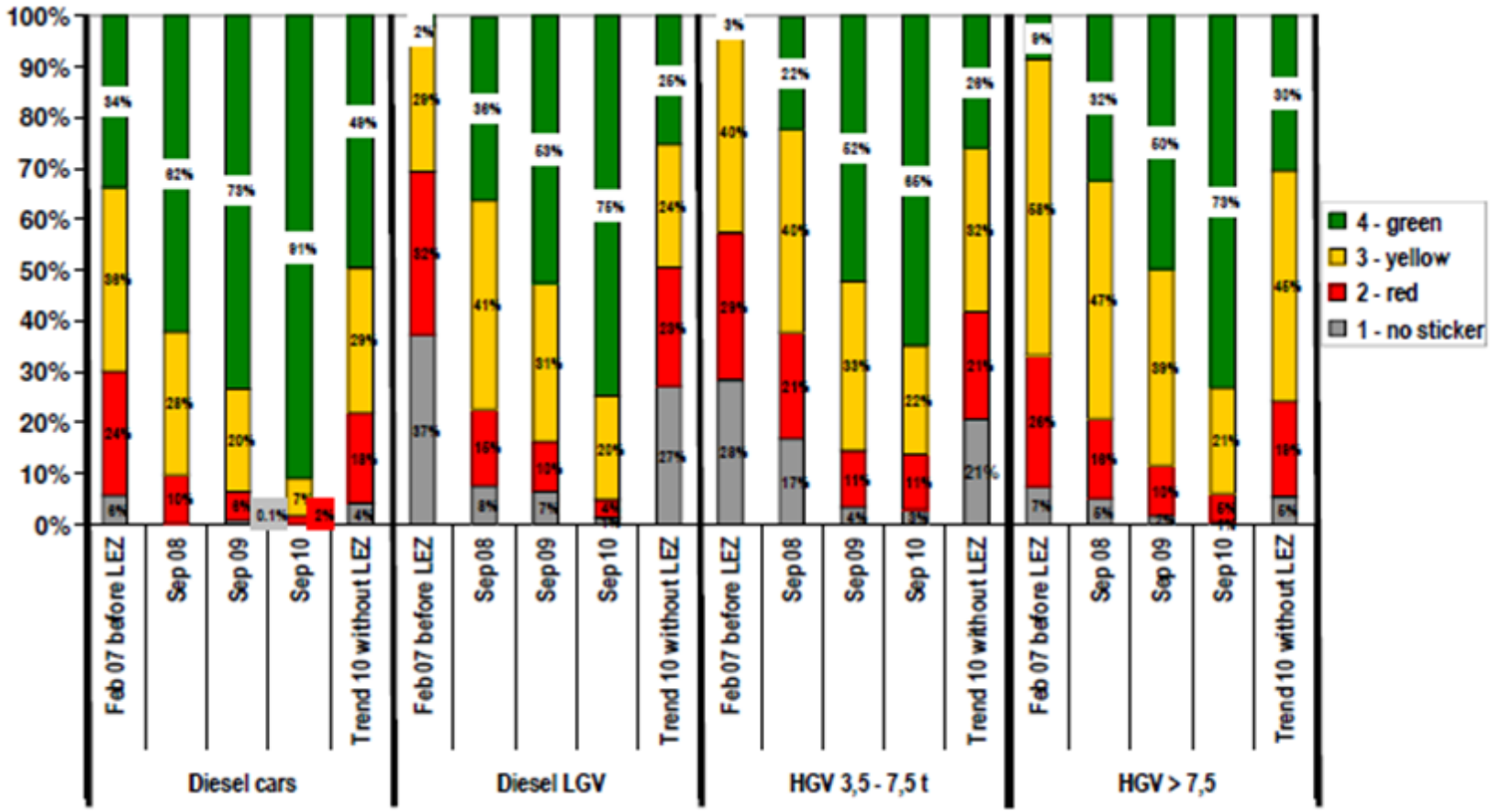
(Berlin total: 3,4 Mio)

☝ more than 40 LEZ planned/in force in Germany, 30 LEZ in the EU, but with different emission criteria

Berlin Environmental Zone Impact Analysis

change of the vehicle fleet composition on the road

(from number plate recognition)

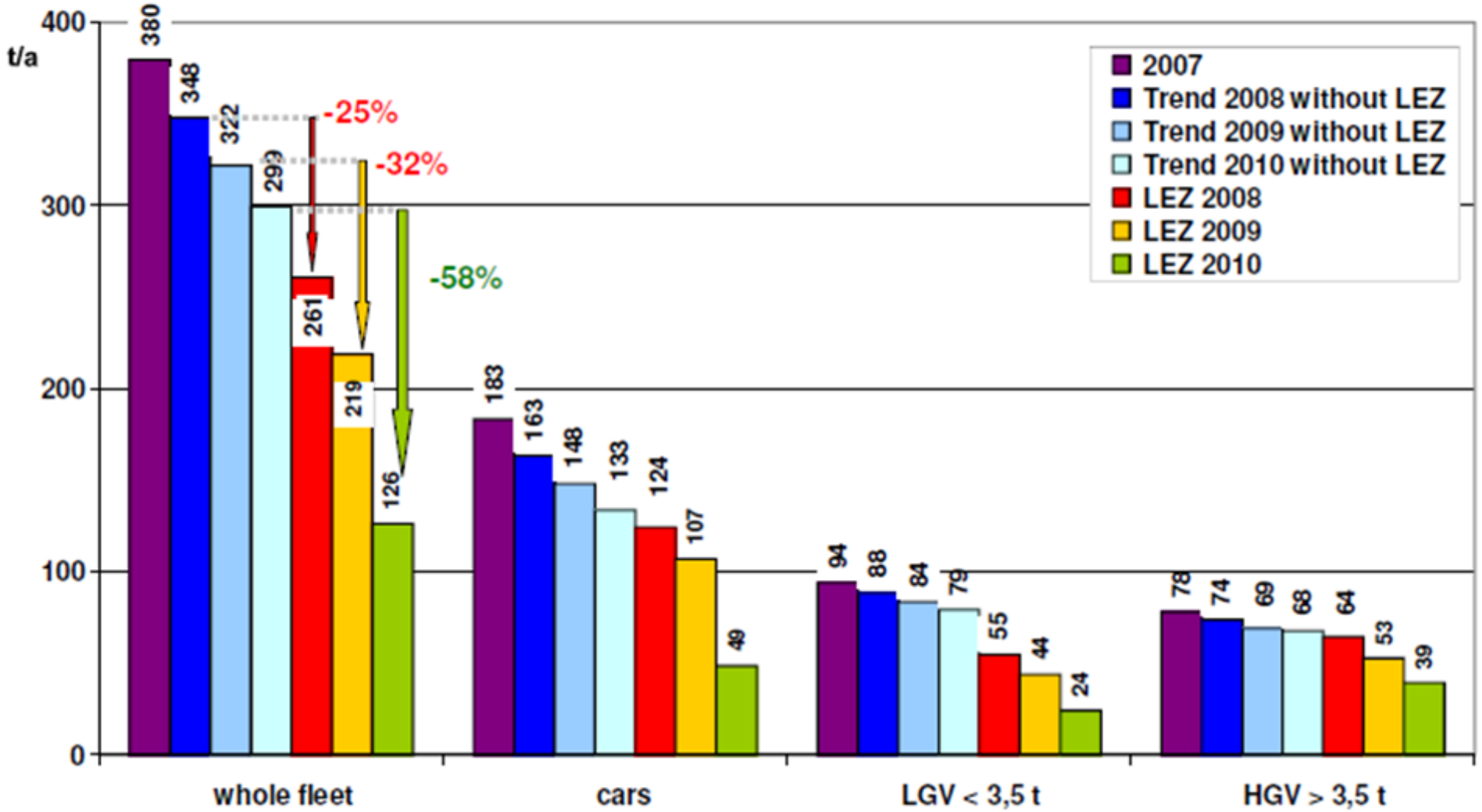


decrease: cat.1 (no sticker) by 70-90 %; Cat 2 (red) by 50-80 %

increase: category 4 (green) by factor 1,5 to 3

Berlin Environmental Zone – Impact Analysis
Particle Emissions-Black Carbon

based on fleet composition at Frankfurter Allee (new emission factor data base HBEFa 3.1)



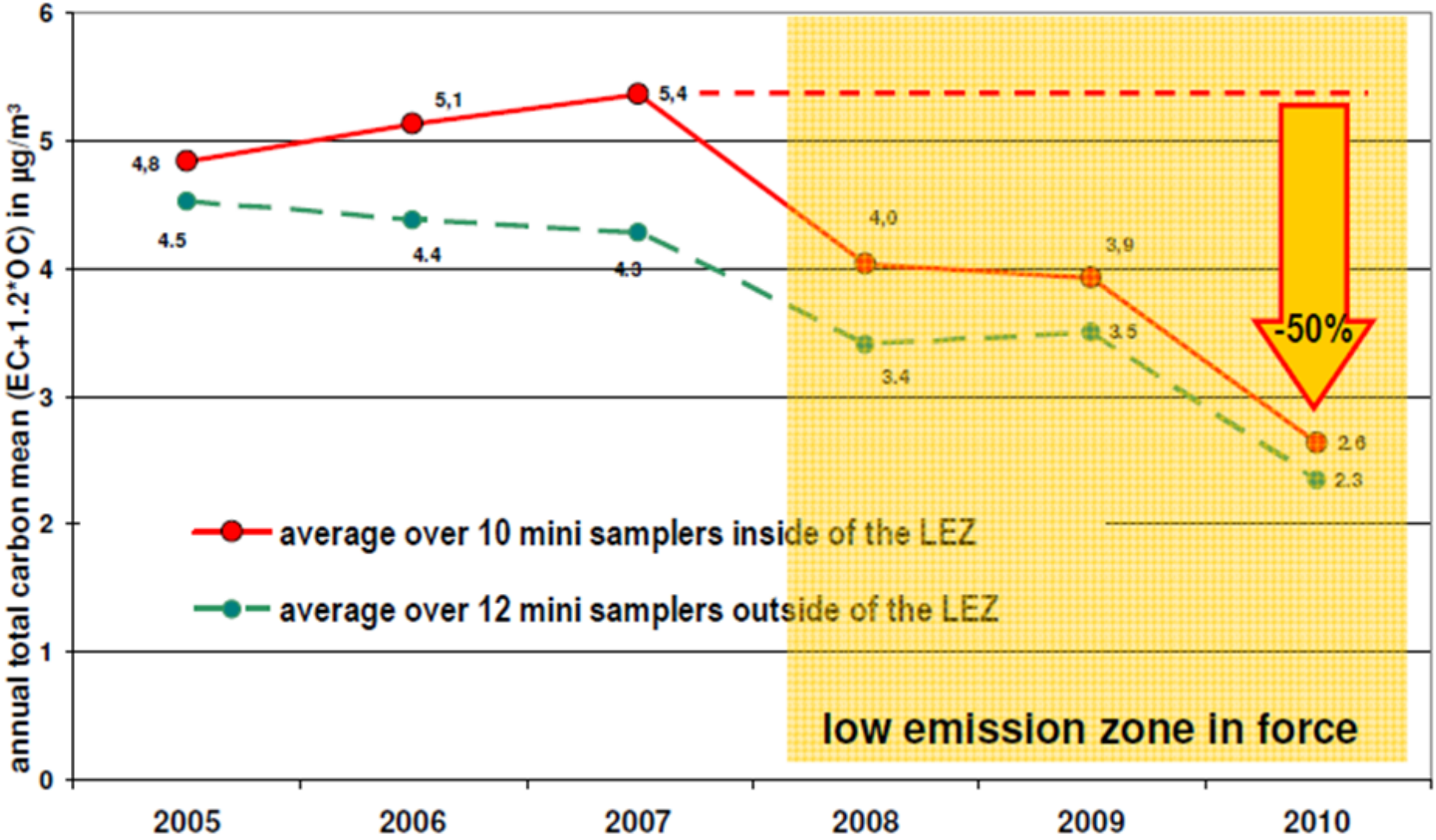
emissions extrapolated to the entire main road network based on the fleet composition at Frankfurter Allee (with DPF-retrofit, only warm emissions, no cold start impact)

(preliminary results, vers. 22/3/2011)

Senate Department for Health, Environment and Consumer Protection, Unit III D, M. Lutz

Berlin Environmental Zone Impact

traffic related* black¥ carbon particle concentration in Berlin



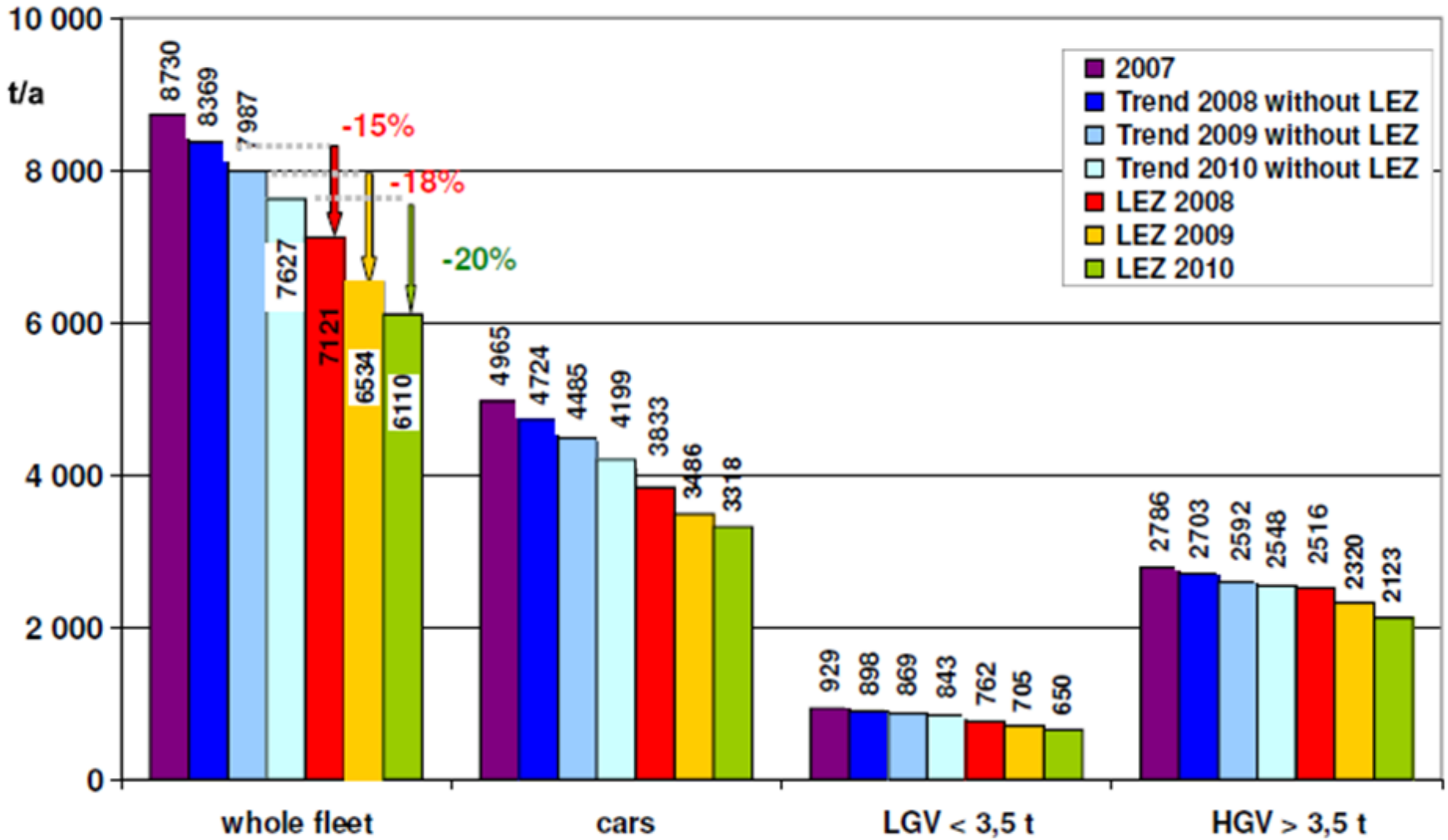
* local BC increment at traffic sites, adjusted to traffic volumes trend relative to 2007 before LEZ came into force

¥ elemental carbon (EC) particles plus other deposited organic compounds (OC)

Senatsverwaltung für Gesundheit, Umwelt und Verbraucherschutz, Referat III D, M. Lutz

Berlin Environmental Zone – Impact Analysis NO_x Emissions

based on fleet composition at Frankfurter Allee (new emission factor data base HBEFa 3.1)



emissions extrapolated to the entire main road network based on the fleet composition at Frankfurter Allee (with DPF-retrofit, only warm emissions, no cold start impact)

Senate Department for Health, Environment and Consumer Protection, Unit III D, M. Lutz

low emission zone stage 2
affected vehicles

Stage 2: Free entry only with green sticker
affected vehicles 2010:
(according to registration data base of 1. January 2010)

- **Diesel Passenger cars:**
  - **14.000 PC (7%) with red sticker → can barely be retrofitted to**
  - **60.000 PC (30%) with yellow sticker → can be retrofitted to**
- **commercial Diesel vehicles:**
  - **10.000 LDV/HDV (12%) with red sticker → can be partly retrofitted to**
  - **25.000 LDV/HDV (30%) with yellow sticker → can be retrofitted to**

affected vehicles in total: ca. 124.000
by mid 2010: 25% Diesel PC & 18% LGV/HGV retrofitted!
40% of Diesel PC have a DPF with 60% closed systems

Health
(Ultrafine Particles)

Ultrafine Particle Study Women in North- Rhine-Westfalia

Long term Health Effectsof Ultrafine Particles

Landesamt für Natur, Umwelt und Verbraucherschutz Nordrhein-Westfalen

LANUV-Fachbericht 31

(www.lanuv.nrw.de)

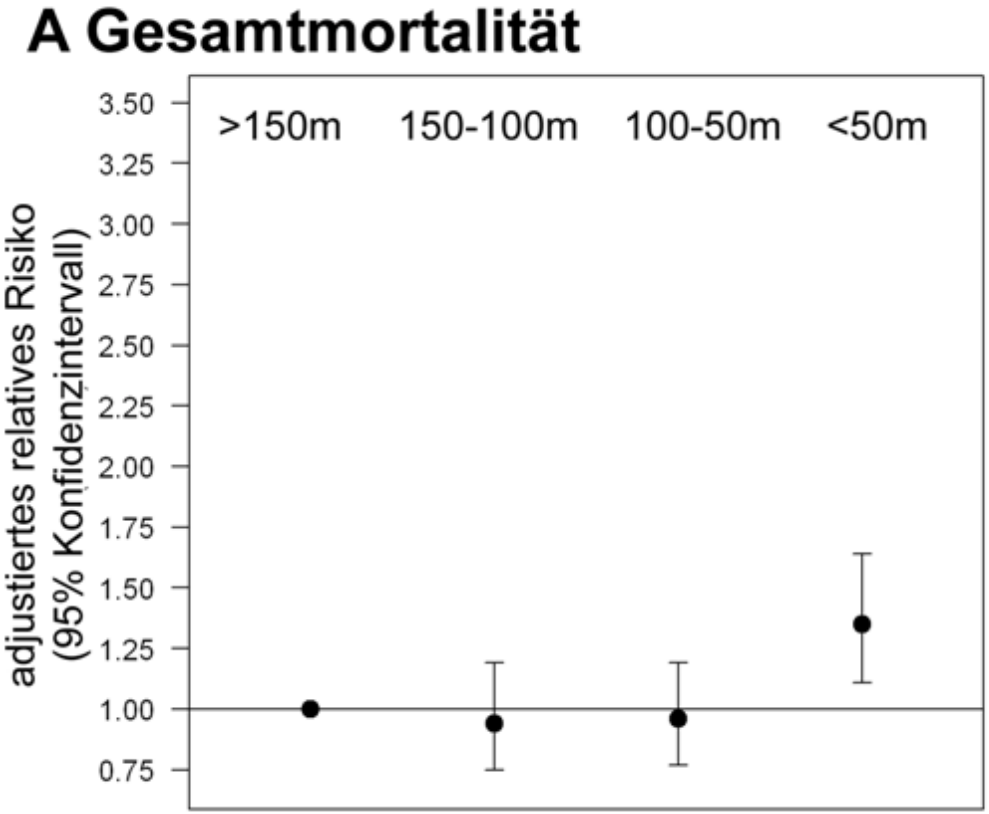
http://www.lanuv.nrw.de/veroeffentlichungen/fachberichte/fabe31/fabe31.pdf

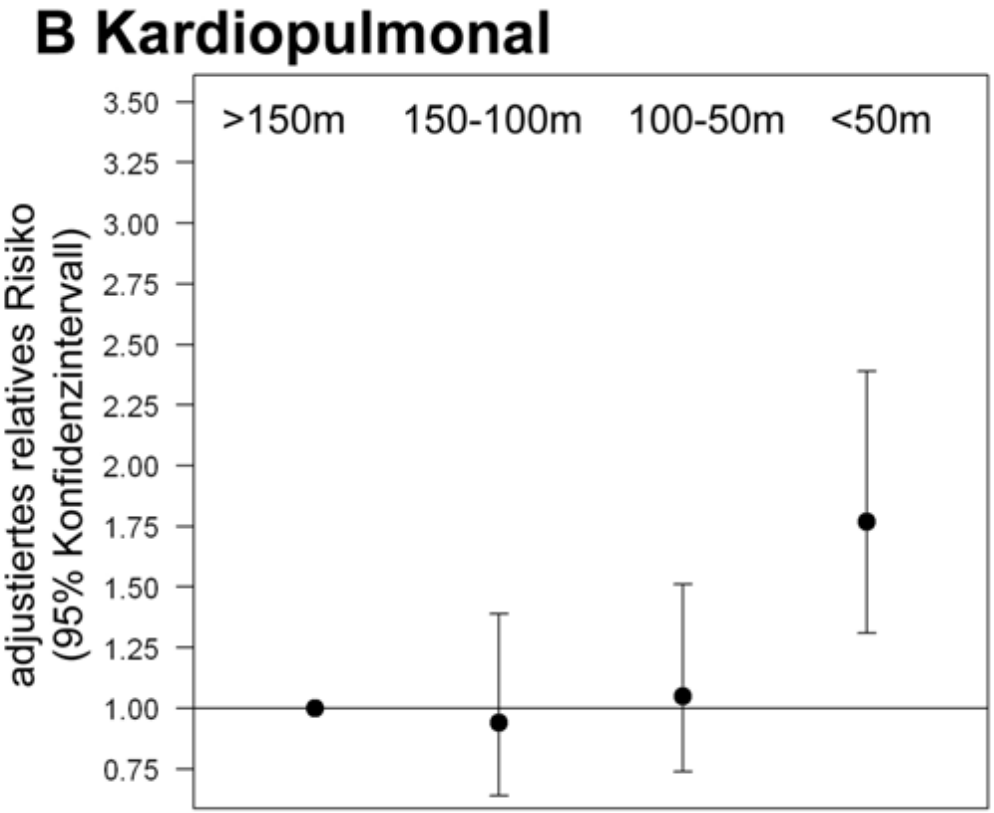
Wichmann, Thiering, Heinrich 2011

Living near on traffic intensive roads

Distance less than 50 m

Increase of total mortality by 38% and of cardiopulmonal death cases by 77%





Verkehrsreiche Straßen: 5000 Fahrzeuge pro Tag; aRR: adjustiert für Sozialstatus und Rauchen

Wichmann, Thiering, Heinrich 2011

The effect of particle size on cardiovascular disorders – The smaller the worse

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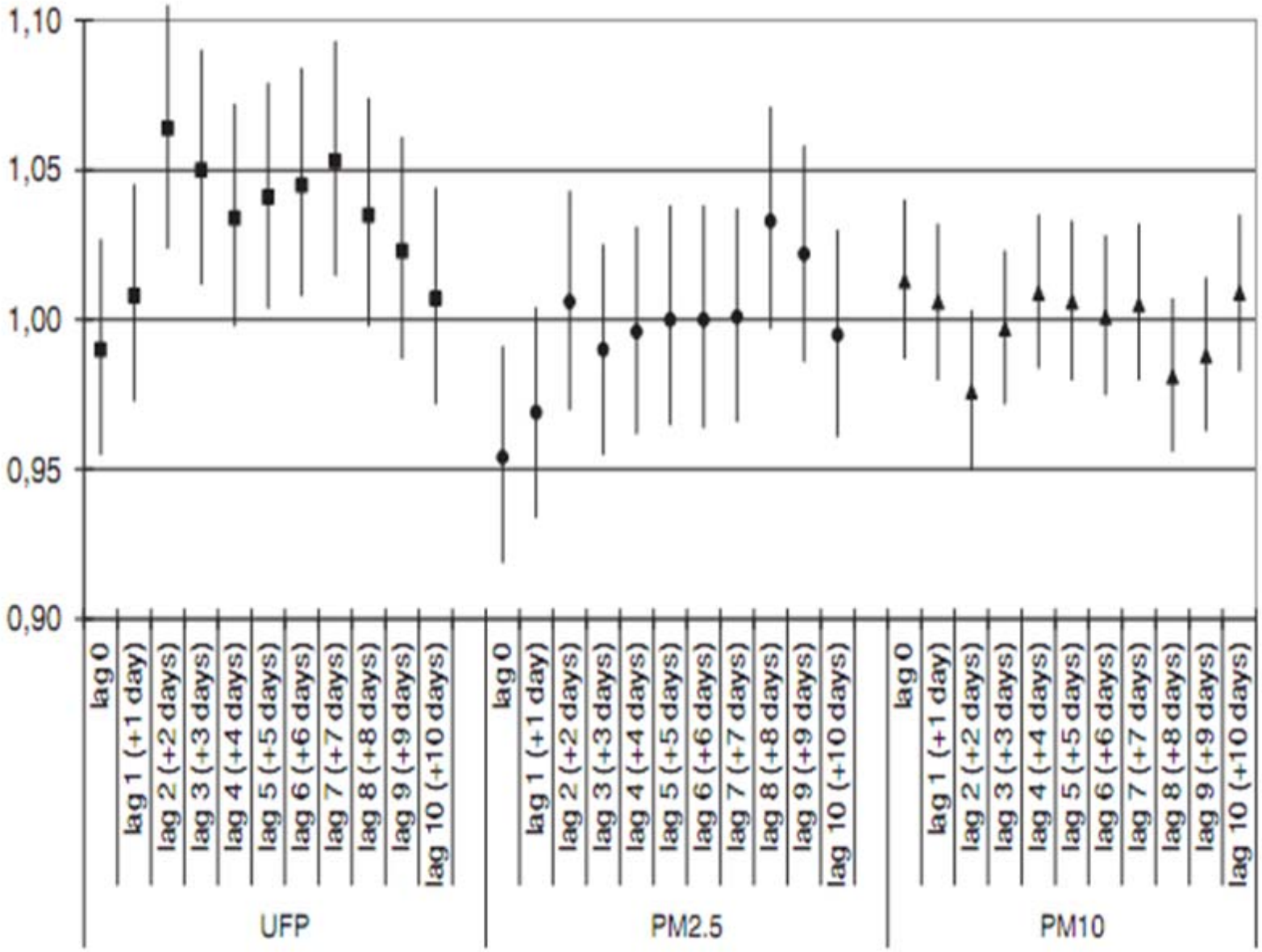
ABSTRACT

Background: Previous studies observed associations between airborne particles and cardio-vascular disease. Questions, however, remain as to which size of the inhalable particles (coarse, fine, or ultrafine) exerts the most significant impact on health.

Methods: For this retrospective study, data of the total number of 23,741 emergency service calls, registered between February 2002 and January 2003 in the City of Leipzig, were analysed, identifying 5326 as being related to cardiovascular incidences. Simultaneous particle exposure was determined for the particle sizes classes <100 nm (UFP), <2.5 μm (PM2.5) and <10 μm (PM10). We used a time resolution of 1 day for both parameters, emergency calls and exposure.

Results: Within the group of cardiovascular diseases, the diagnostic category of hypertensive crisis showed a significant association with particle exposure. The significant effect on hypertensive crisis was found for particles with a size of <100 nm in diameter and starting with a lag of 2 days after exposure. No consistent influence could be observed for PM2.5 and PM10. The Odds Ratios on hypertensive crisis were significant for the particle size <100 nm in diameter from day 2 post exposure OR = 1.06 (95%CI: 1.02–1.10, p = 0.002) up to day 7 OR = 1.05 (95%CI 1.02–1.09, p = 0.005).

Conclusion: Ultrafine particles affect cardiovascular disease adversely, particularly hypertensive crises. Their effect is significant compared with PM2.5 and PM10. It appears necessary, from a public health point of view, to consider regulating this type of particles using appropriate measurands as particle number.



OR and 95% confidence interval in emergency calls related to hypertensive crises depending on time of exposure to airborne particles and size of particles (ultrafine[UFP]–fine [PM2.5]–coarse [PM10])

Source: U. Franck et al. / Science of the Total Environment 409 (2011) 4217–4221

Berlin LEZ – impact analysis health benefit

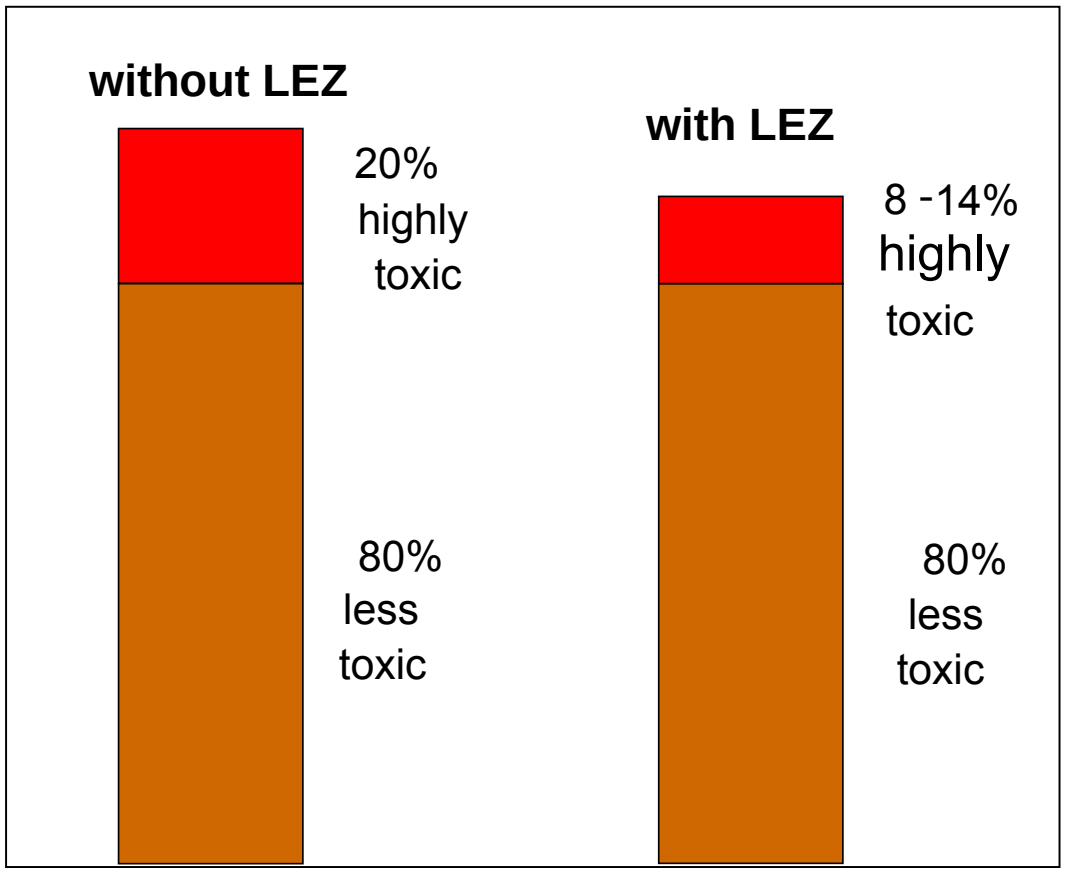
LEZ benefit for public health

some essentials:

about 20% of total PM10 consists of highly toxic diesel soot

30- 60 % reduction of Diesel soot emissions also mitigates health risk by 30-60%,

even though total PM10 levels fall by only about 7 % (in Berlin)



source:: **LEZ and public health protection** by Prof. Dr. med. Dr. rer. nat. Erich Wichmann, Helmholtz Zentrum München Institut für Epidemiologie I (press conference Deutsche Umwelthilfe 7.4.2011 Berlin)

Estimation of the Health Impact of the Environemntal Zones Berlin und München

Reduction of the traffic related soot concentration by about . 30% (60%)

yearly death cases caused by diesel soot in urban areas 240 per 1 Million inhabitons

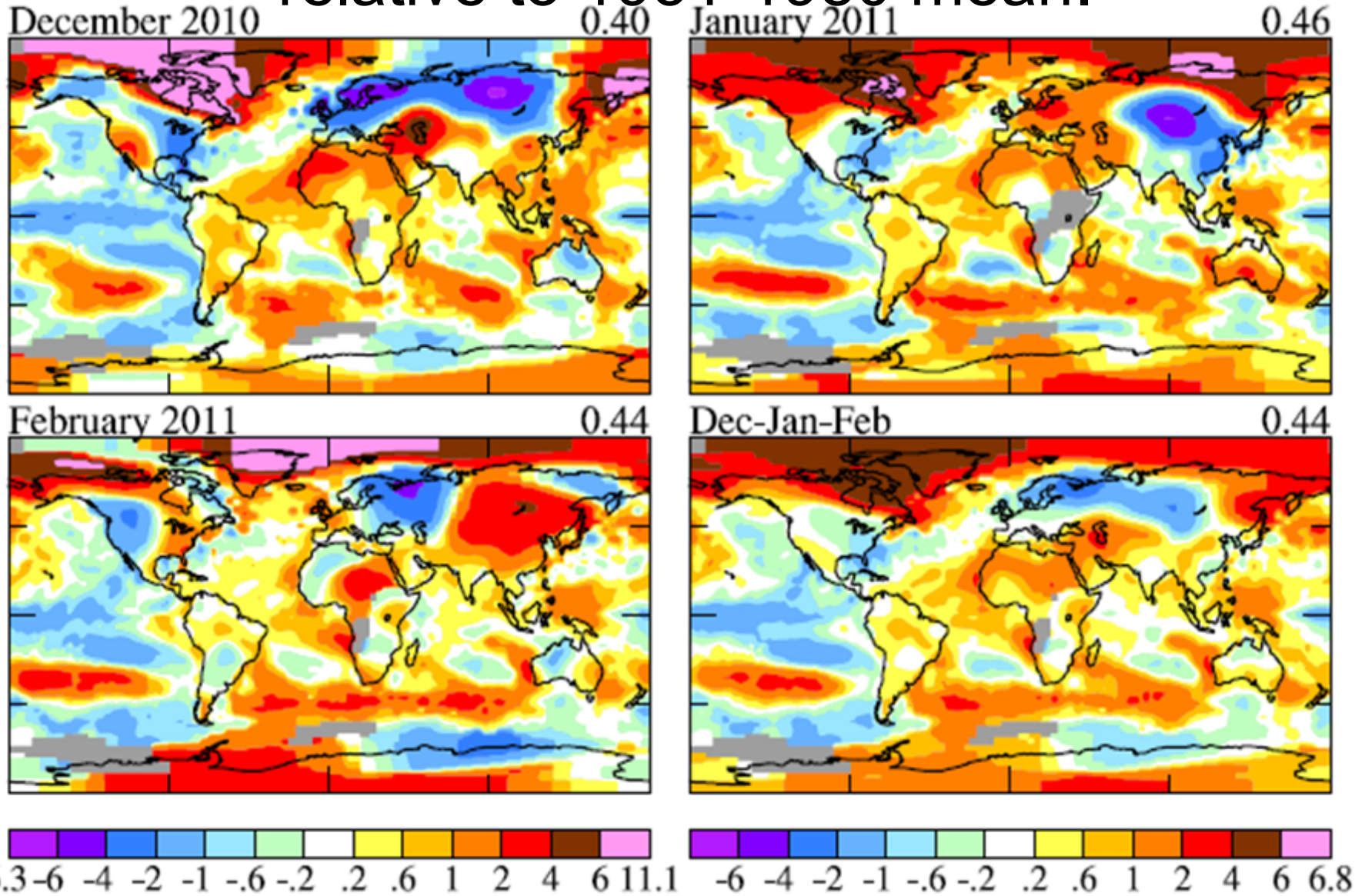
30% (60%) of this: 72 (144) per 1 Million EW

	Berlin	München
People in the EZ	~ 1.000.000	~ 420.000
All death cases per year in the EZ	~ 10.000 (100%)	~ 4.200 (100%)
Avoided death cases per year by EZ		
(red/yellow/green label)	~ 72 (0,72%)	~ 30 (0,72%)
(only green label)	~ 144 (1,44%)	

Estimation: Per year about 144 premature death avoided in Berlin and about 30 in Munich by the implementation of the Environmental Zone

Climate

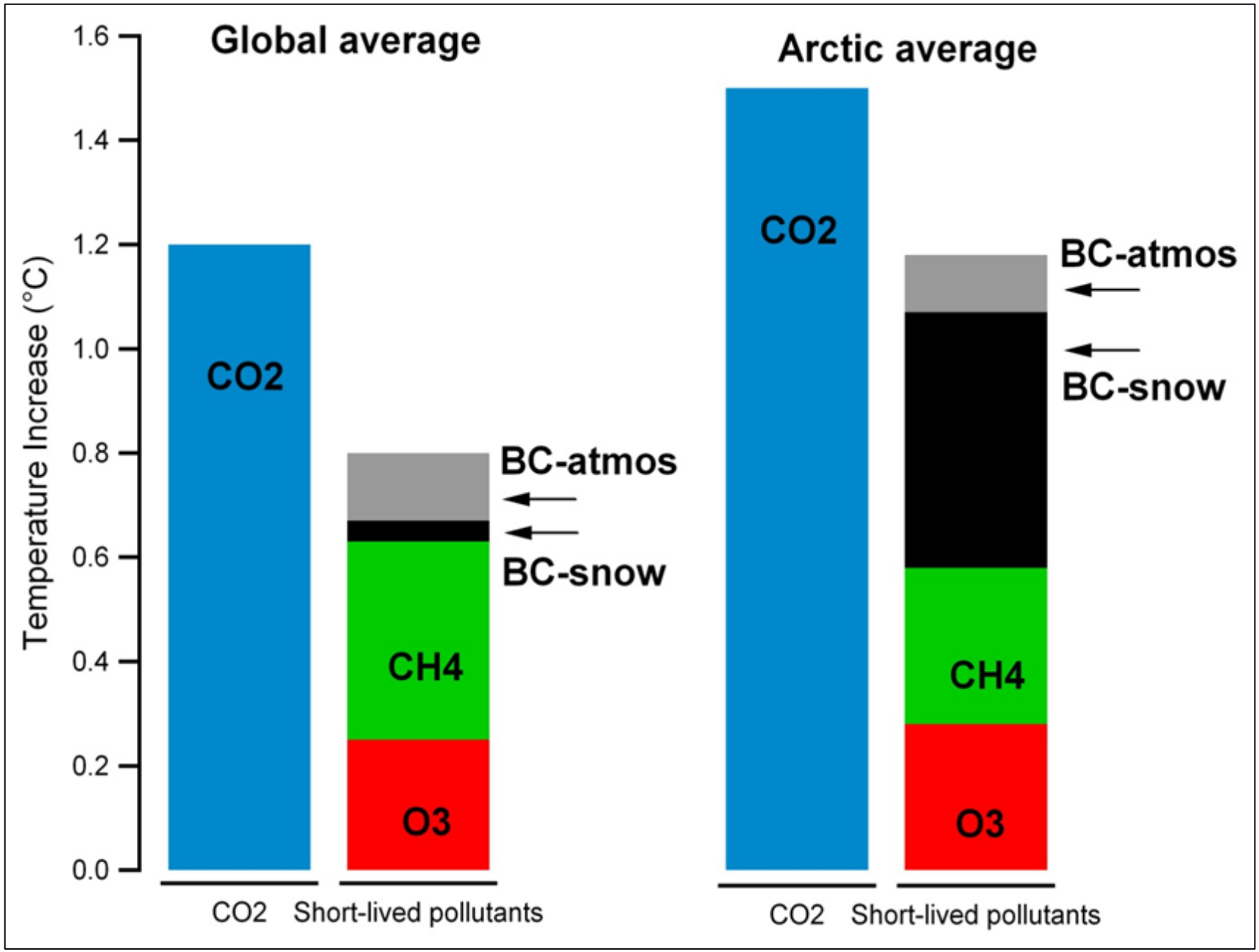
Surface temperature anomalies in Northern Hemisphere winter 2010-2011 relative to 1951-1980 mean.



Source: Hansen, J., R. Ruedy, M. Sato, K. Lo, 2010: Global surface temperature change, Rev. Geophys., 48, RG4004, 29 pp.

Global vs. Arctic Warming

1830 to the Present



Source: Arctic Monitoring & Assessment Program (AMAP A working group of the eight nation Arctic Council

Shindell, Faluvegi - April 2009

Black Carbon responsible for 50% or nearly 1.0º C of the 1.9º C temperature increase in the Arctic from 1890 to 2007

20- and 100-year global warming potentials (GWPs) for fossil-fuel soot and black carbon within fossil-fuel soot.

X	20-year GWP	100-year GWP
FF soot	2530	840-1280
BC in FF soot	4470	1500-2240

The global warming potential is defined here as the change in temperature per unit emissions of X relative to the change in temperature per unit emissions of CO2. Multiply the GWPs in the table by 12/44 to obtain the GWP relative to CO2-C. BC= black carbon. FF soot=56% black carbon + 43% primary organic carbon + 1% sulfate

Legal Aspects

1. Court decision: Federal Administrative Court Leipzig

March, 20th 2007

Legal Action at the federal administrative court Leipzig. Claimant was a citizen, Mr. Janecek from Munich, supported by the DUH, against the free state of Bavaria and the city Munich.

Mr. Janecek demanded extensive actions against particulate matter emissions

September, 27th 2007

The Federal Administrative Court confirms „enforcable right of clean air“. The city can be pledged to install „reasonable“ arrangements

Citizens have the right to demand arrangements which are beyond the existing concept.

=> The city has to override existing rules and act immediately against high particulate matter emissions.

2. Fundamental Decision: European Court of Justice; July, 25th 2008

The European Court of Justice established the enforceable right of clean air. **Affected citizens have the right with immediate effect to claim effective arrangements by the city.**

Affected citizens are entitled to demand that the city council installs action plans as well as plans for short-term arrangements, including immediate arrangements to improve the air quality.

The action plan has to include arrangements which make the compliance of the limits requirements step by step possible.

- October 2008 the environmental zone in Munich was established

All essential court decisions in the last years have been decided in favor of the established environmental zones and in favor of the concerned citizens.

Consequence: 44 Environmental Zones in Germany

Problems:

Most environmental zones aren't correctly implemented :

- lack of control and enforcement
- lack of strictness (e.g. only red labels not allowed)
- too small, size matters!!

→ We need more legal actions concerning the embodiment of Environmental zones

What was new in 2012?

Deutsche Umwelthilfe (DUH) claims today

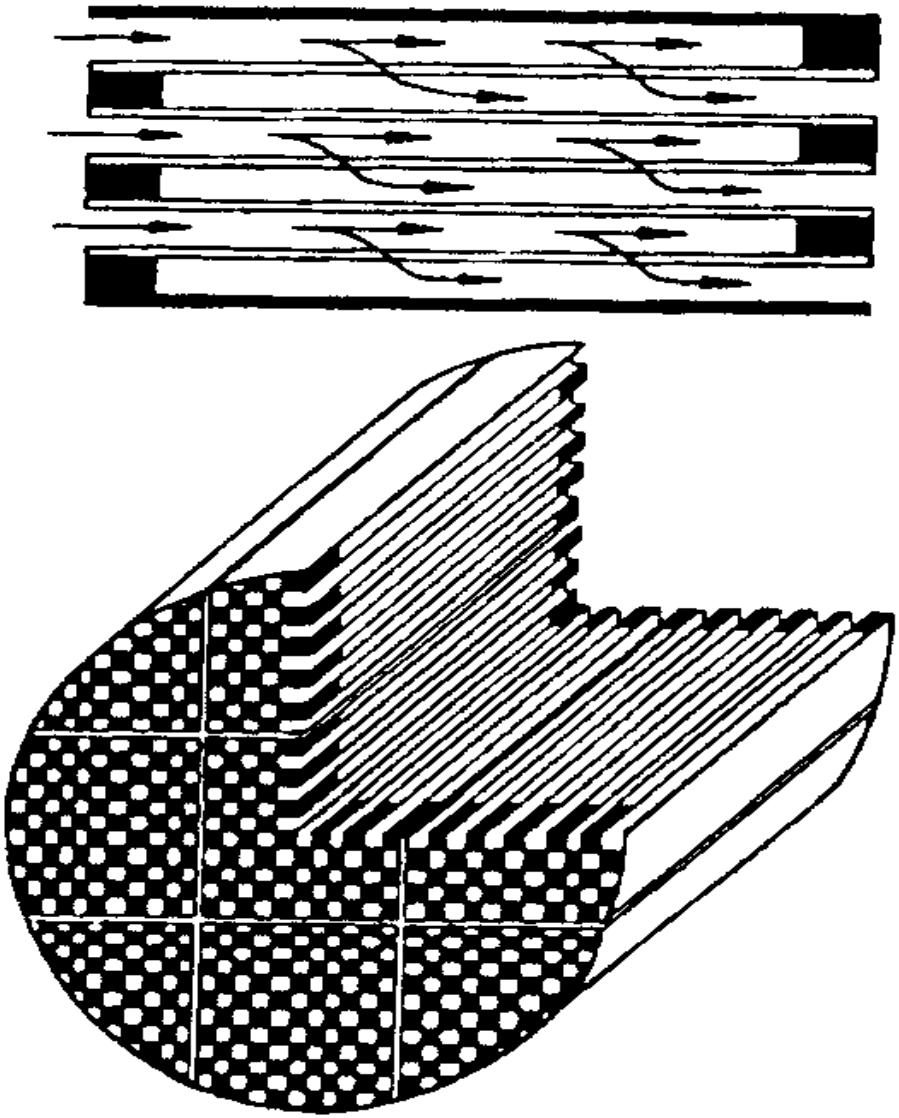
5 legal cases in different cities:

- Wiesbaden
- Mainz
- Darmstadt
- Reutlingen
- München
- planned Stuttgart and Cologne and others

Abatement

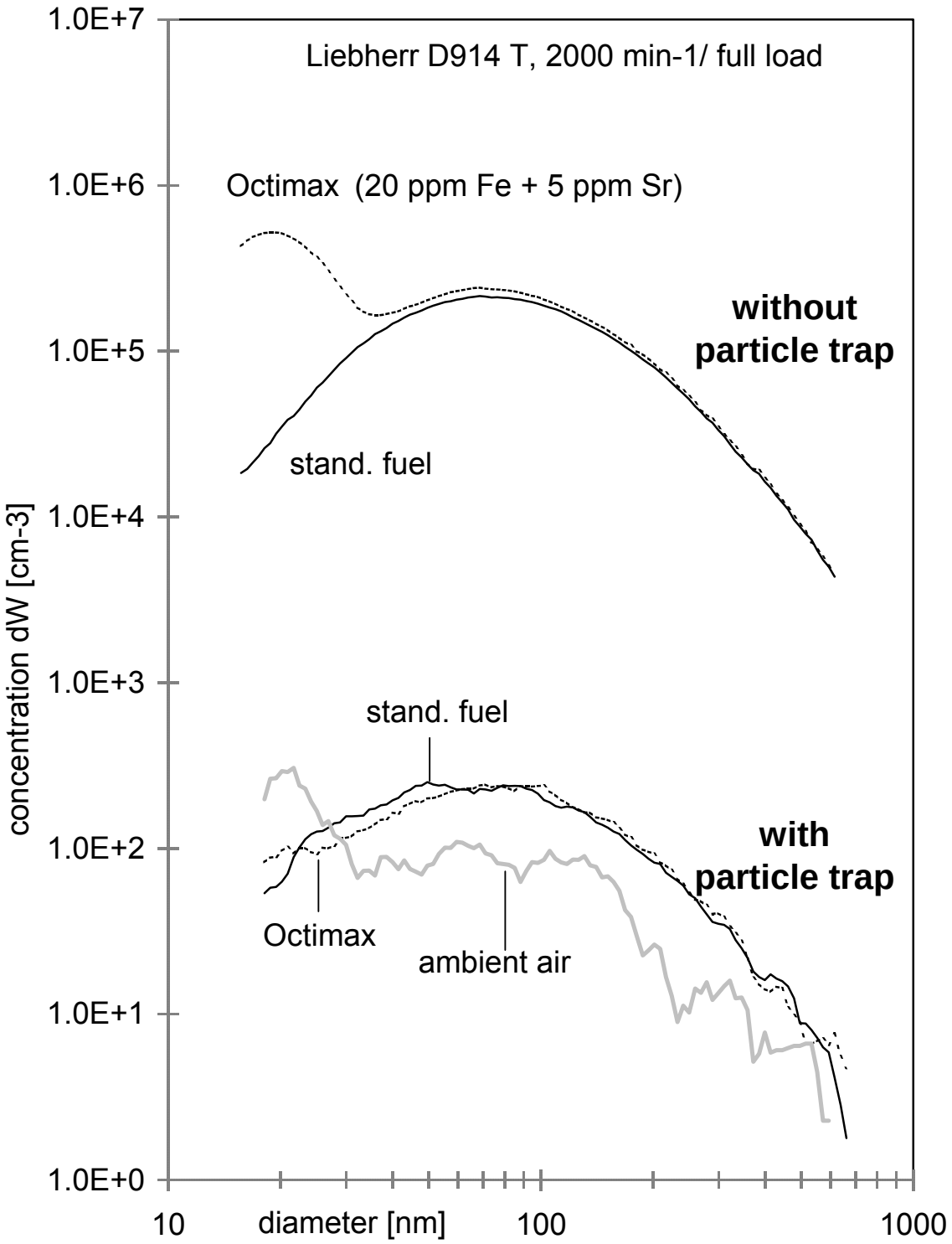
The classic CORNING wall flow ceramic Substrate

Source CORNING 1982

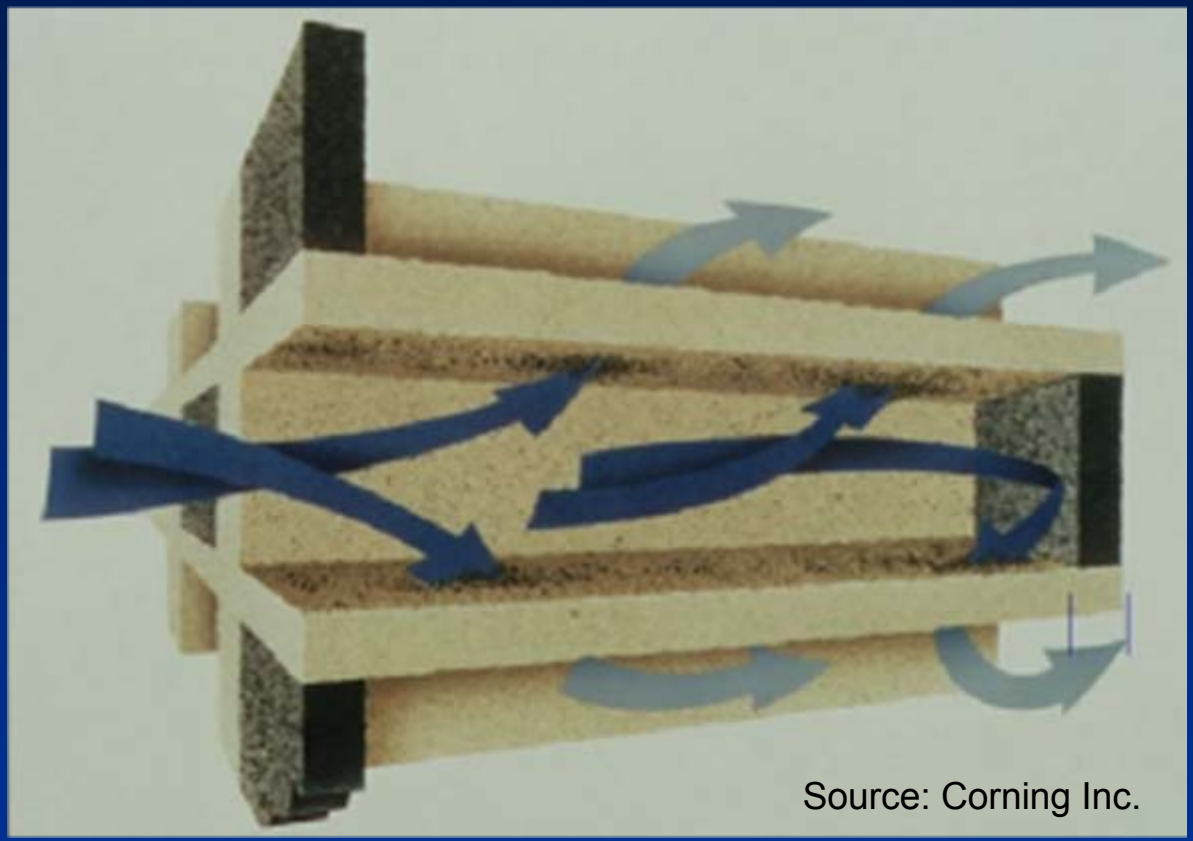


Particle Elimination

with Particle-Filter

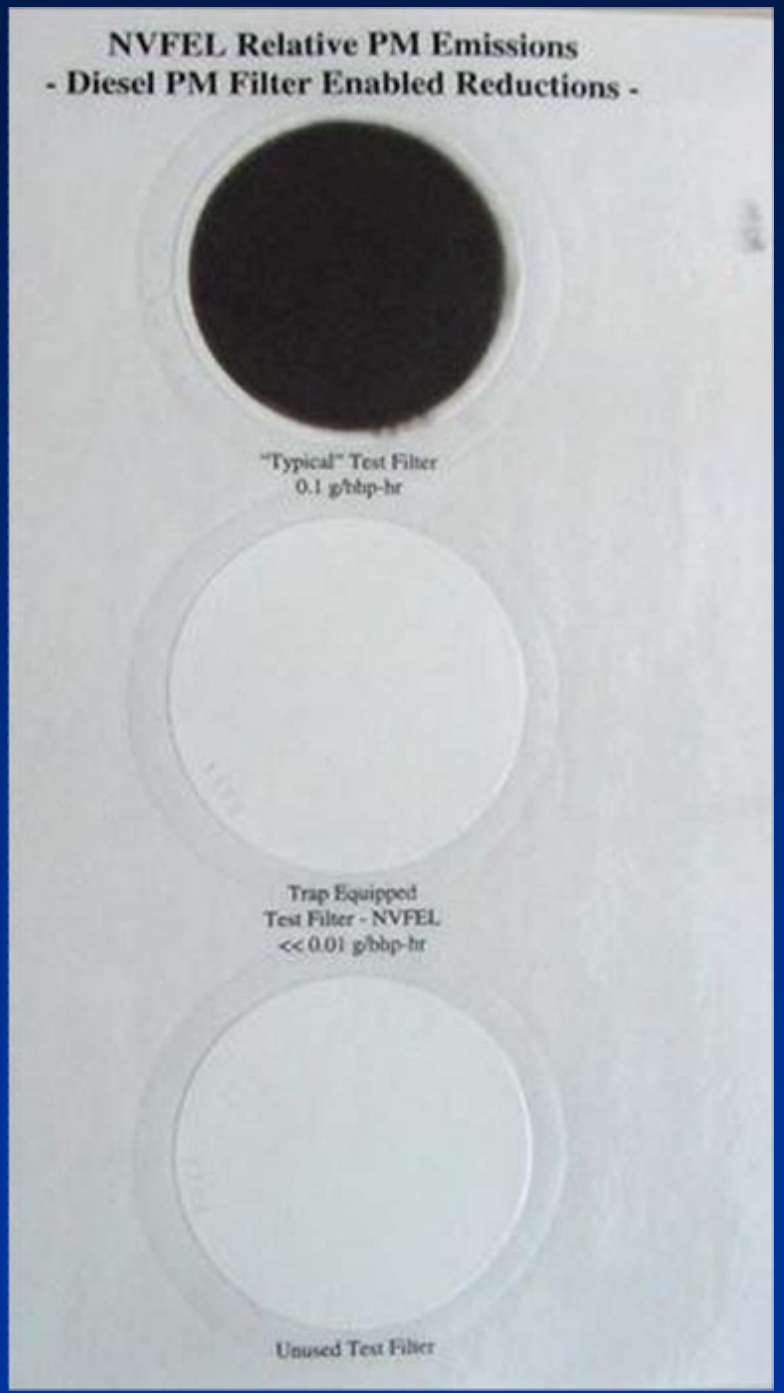


Enabling Near Zero Emission Levels



Source: Corning Inc.

Diesel Particulate Filters (CDPFs) eliminate more 99% of solid particles (soot & metals)



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I have a Dream:
Überall ist Kopenhagen!

Stau in der Rushhour in Kopenhagen Quelle: Fairkehr, April 2008