

# Bases científiques i tècniques per a la millora de l'aire urbà

Fotografia: Observatori Fabra



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Qualitat de l'aire: situació i alternatives, Fundació Gas Natural, Barcelona 12 Maig 2011

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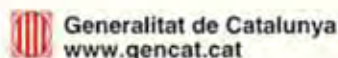


# Collaboration

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Generalitat de Catalunya



**Miró J.V.**  
Generalitat Valenciana



# Content

- The problem of  $\text{NO}_2$
- The problem of PM
- Measures for air quality improvement ( $\text{NO}_2$  & PM)
- Conclusions



**BASES CIENTÍFICO-TÉCNICAS  
PARA LA ELABORACIÓN DEL PLANES  
DE MEJORA DE LA CALIDAD DEL AIRE  
RELATIVO AL MATERIAL PARTICULADO Y  $\text{NO}_2$   
EN ESPAÑA**



## ATMOSPHERIC POLLUTION

*“Comparing the air from cities and deserts and arid terrains is like comparing fetid and dirty waters with pristine waters. In the city, due to the high of the buildings, the narrow streets and all emissions from the inhabitants and their wastes..... the air is stagnant, dense and foggy ... If the air is slightly altered, the psychical spirit will be also noticeably altered.”*

*Maimónides (Rabi Mose Ben MAIMON)*

*Sefardí Doctor from Cordoba, Spain, 1135–1204*



# Critical Air Quality problems in EU

293 °K , 101,3 kPa

Directive 2008/50/CE  
Cond.

except PM and metals, Evriron.

Hourly	350 µg/m <sup>3</sup> SO <sub>2</sub>	24 times per year
Daily	125 µg/m <sup>3</sup> SO <sub>2</sub>	3 times per year
Annual prot. ecos.	20 µg/m <sup>3</sup> SO <sub>2</sub>	not exceeding annual and mean 1 Oct-31 Mar
Hourly	200 µg/m <sup>3</sup> NO <sub>2</sub>	18 times per year from 2010
Annual	40 µg/m <sup>3</sup> NO <sub>2</sub>	not exceeding from 2010
Annual prot. vegetation	30 µg/m <sup>3</sup> NO <sub>x</sub>	(reported as NO <sub>2</sub> ) not exceeding, from 2010
Annual	30 (5) µg/m <sup>3</sup> Benzene	not exceeding from 2010
Mean 8-h max. in a day	10 mg/m <sup>3</sup> CO	not exceeding
Annual	500 ng/m <sup>3</sup> Pb	not exceeding
Annual	40 µg/m <sup>3</sup> PM <sub>10</sub>	not exceeding
Daily	50 µg/m <sup>3</sup> PM <sub>10</sub>	n<35 per year
Annual	(25 y 20 (18) µg/m <sup>3</sup> PM <sub>2.5</sub> )	not exceeding
2010-2020	<del>(reducing 20% PM<sub>2.5</sub> triennial for mean of urban background)</del>	
2004/107/CE		
Annual	6 ng/m <sup>3</sup> As	not exceeding
Annual	20 ng/m <sup>3</sup> Ni	not exceeding
Annual	5 ng/m <sup>3</sup> Cd	not exceeding
Annual	1 ng/m <sup>3</sup> Benzo[α]pirene	not exceeding

**CRITICAL PARAMETRES**

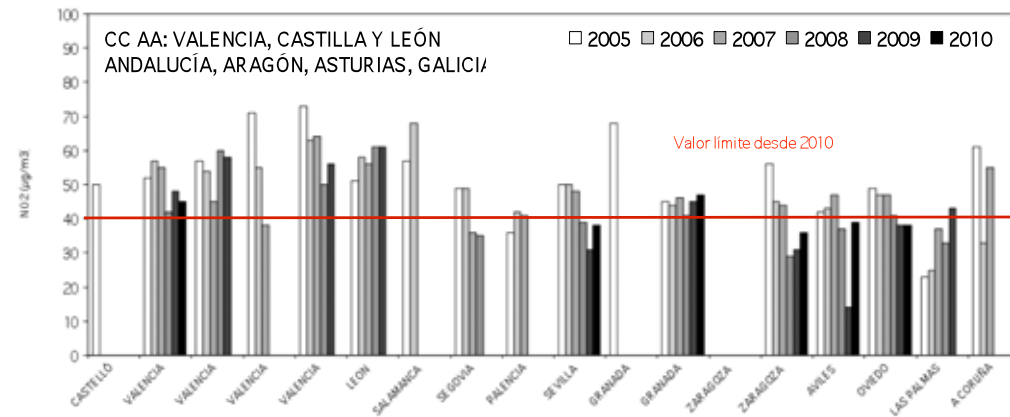
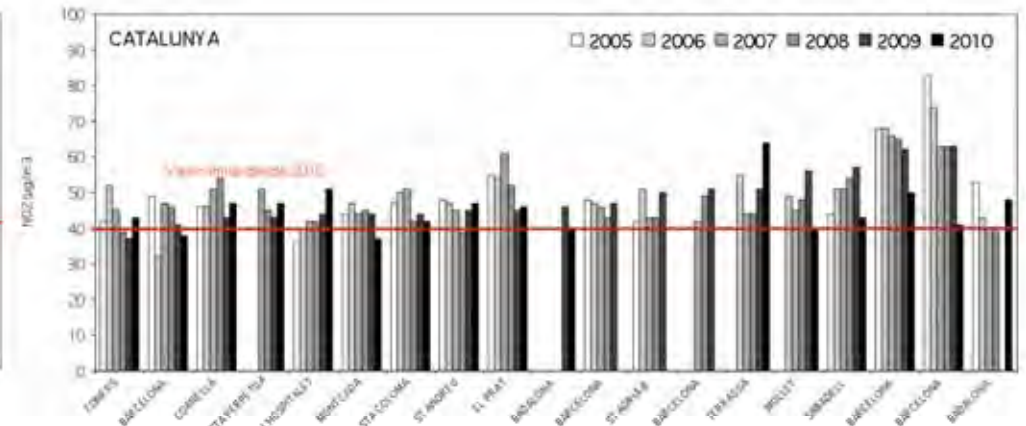
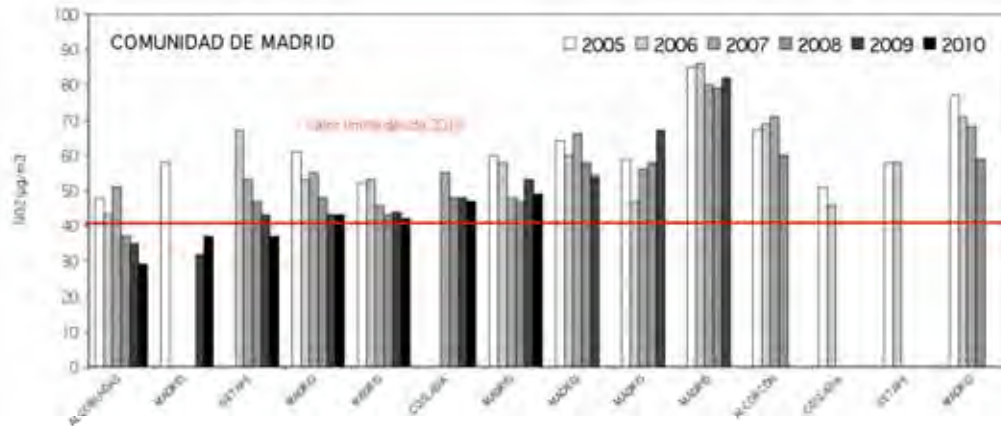


# The problem of NO<sub>2</sub>

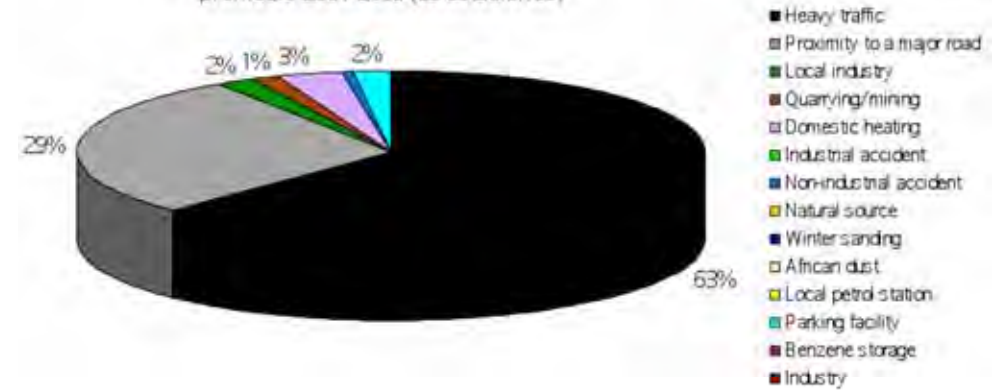


GOBIERNO DE ESPAÑA

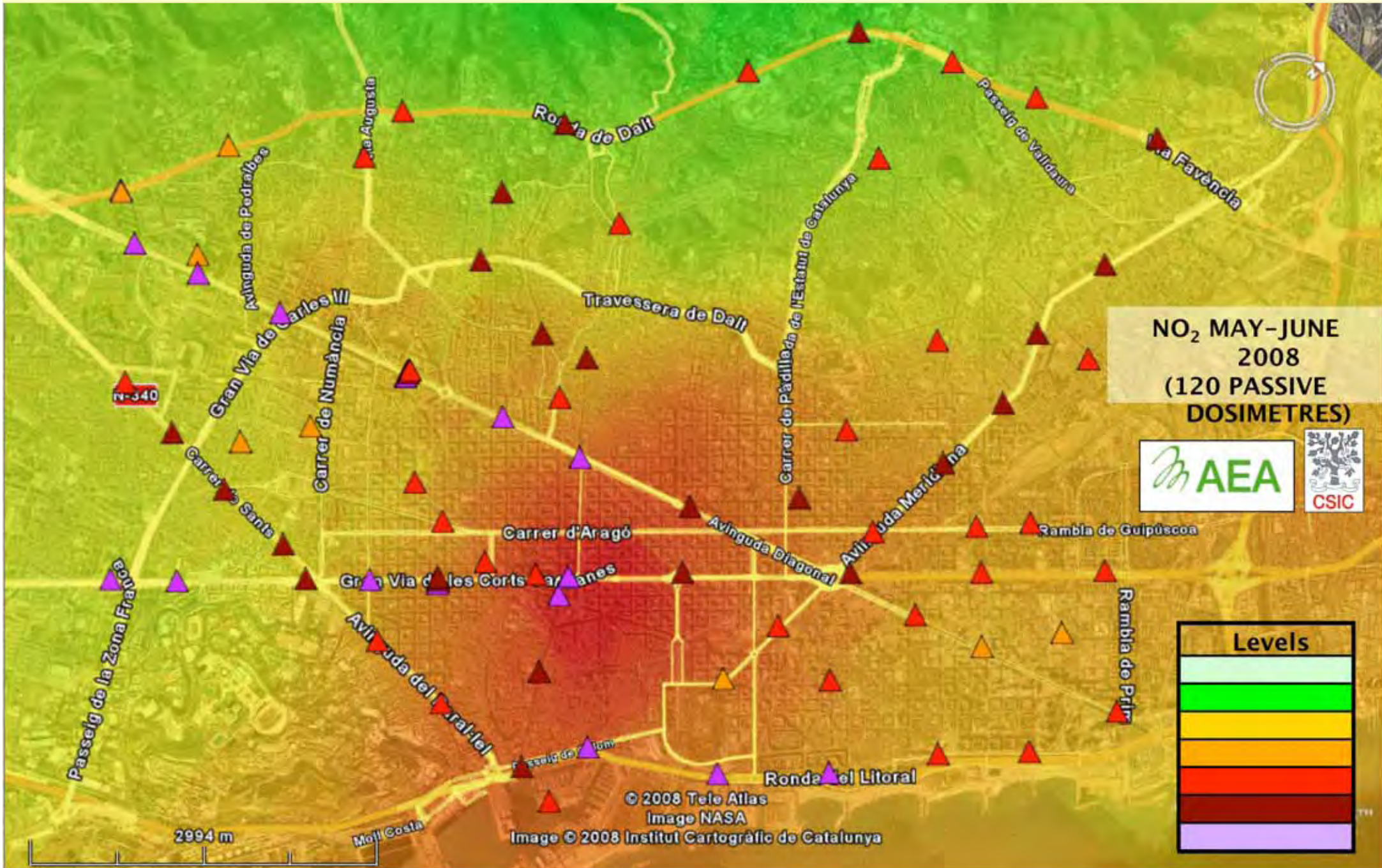
MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO



Causas de superación del VLA de NO<sub>2</sub> promedio 2001-2009 (53 estaciones)

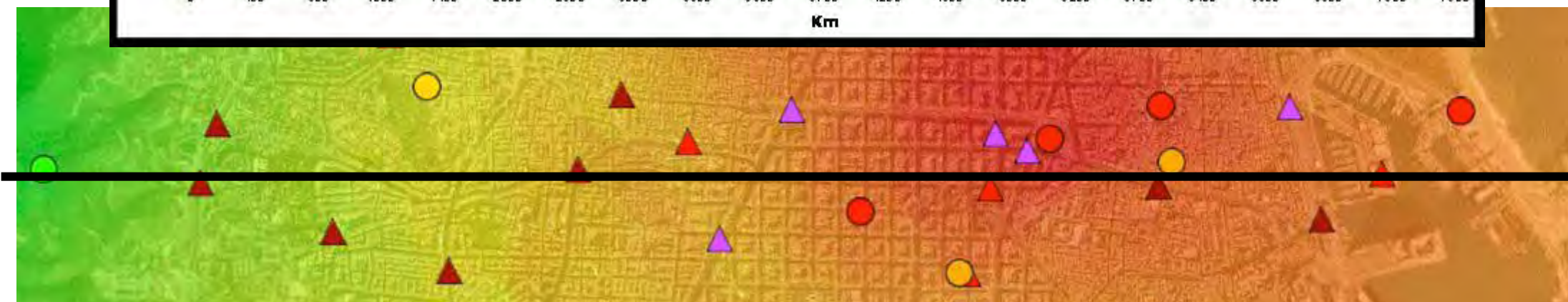
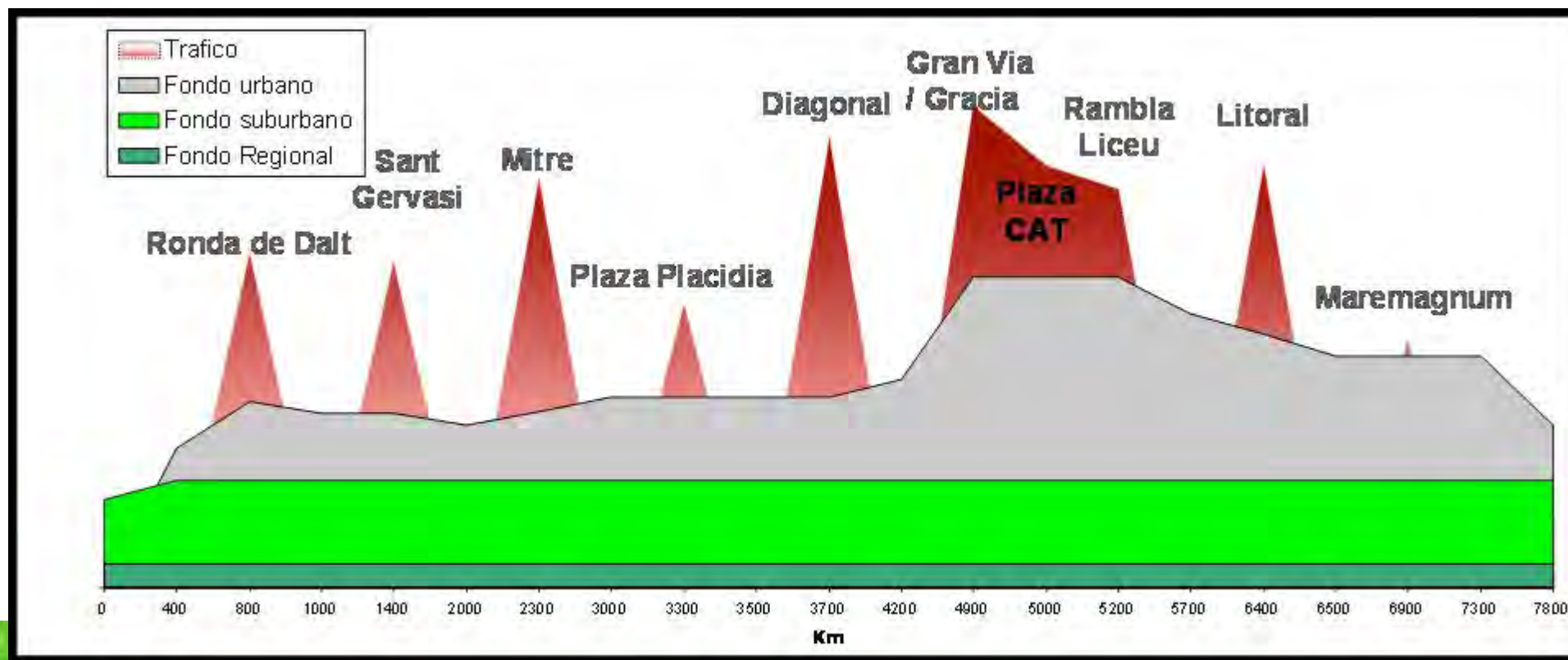


# The problem of NO<sub>2</sub>



# The problem of NO<sub>2</sub>

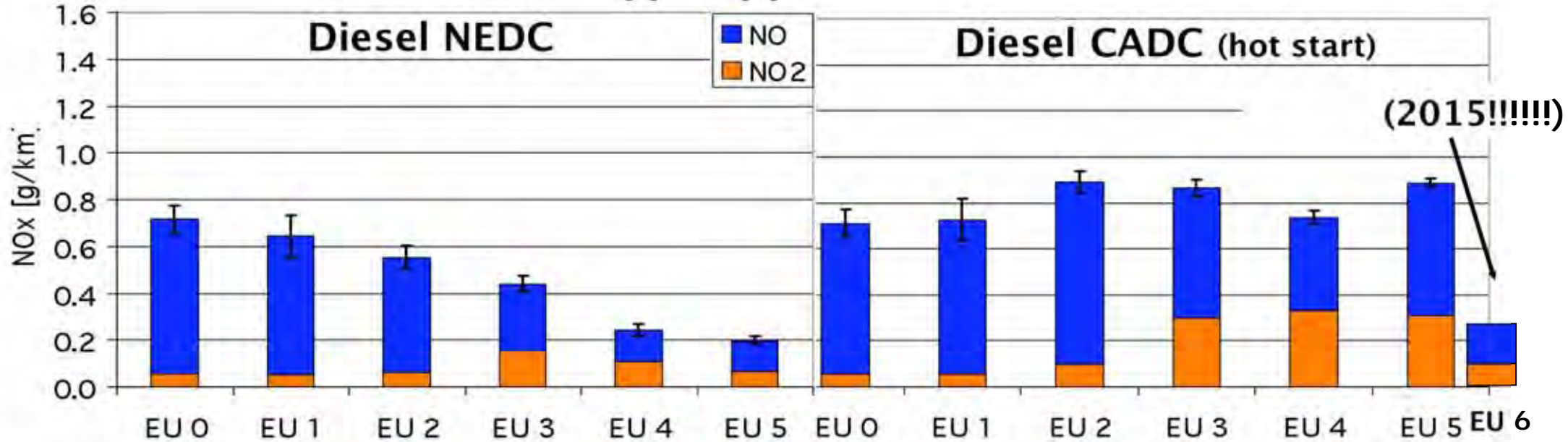
NO<sub>2</sub> MAY-JUNE 2008 (120 PASSIVE  
Fabra - DOMINIOS)



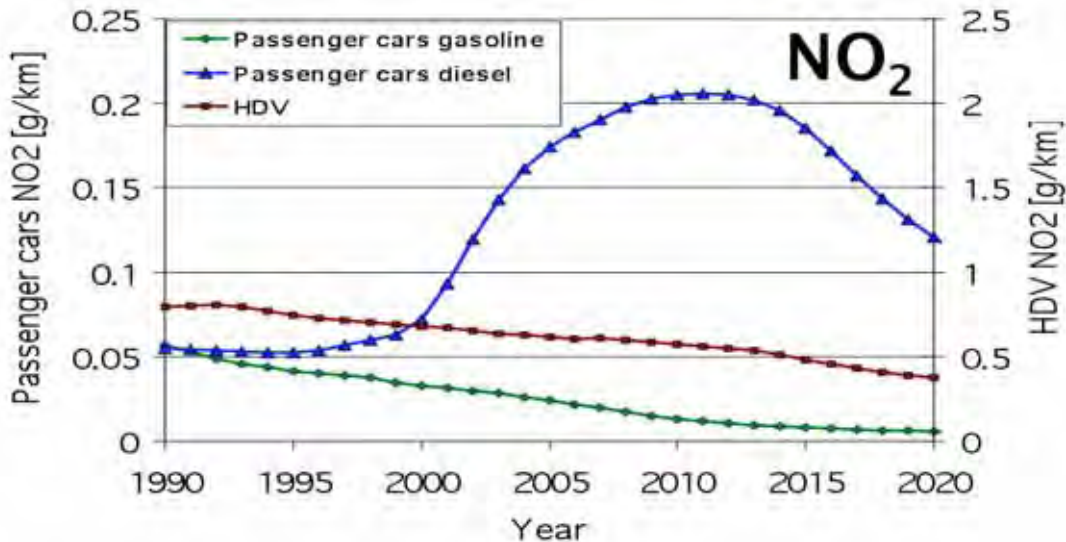


# The problem of NO<sub>2</sub>

Actual emissions: type approval vs. real world for PC



NO<sub>2</sub> fleet emission factors in urban traffic (share in mileage for AUT)



Total effect of NO<sub>x</sub> and NO<sub>2</sub> fleet emission reduction may not be sufficient to reach NO<sub>2</sub> air quality targets near roads with high traffic volumes until 2015:

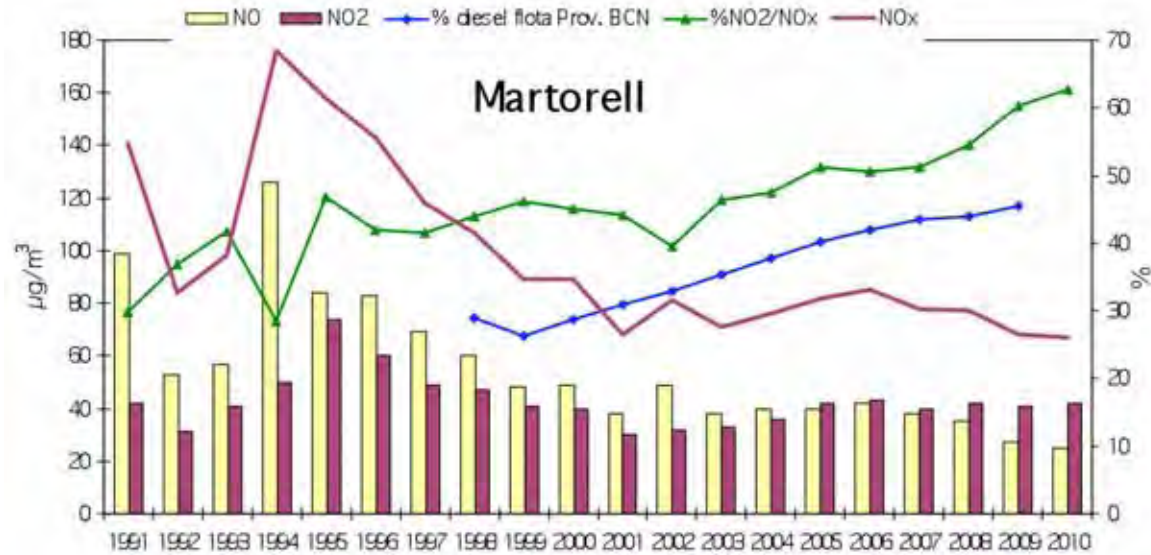
**URGENT NON TECHNOLOGICAL MEASURES (REDUCTION OF N VEHICLES) REQUIRED**

Courtesy: Prof. Dr. S. Hausberger T.U. Graz

# The problem of NO<sub>2</sub>

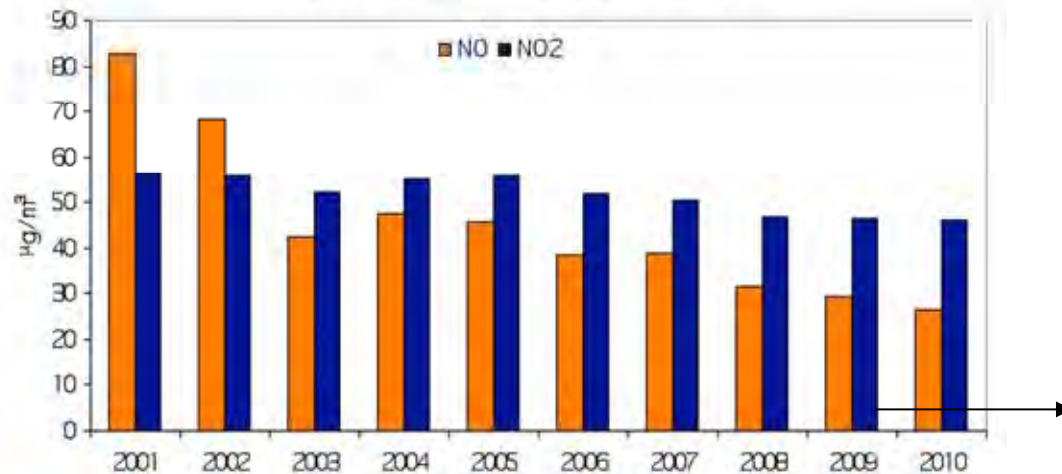
## NO & NO<sub>2</sub> 1990-2010 TRENDS

Generalitat de Catalunya  
Departament de Medi Ambient  
i Habitatge



Evolución de los valores medios de NO y NO<sub>2</sub> en las estaciones que permanecen en la red

MADRID! AREA DE GOBIERNO DE MEDIO AMBIENTE



Dieselization + increase O<sub>3</sub> ??? (NO + O<sub>3</sub> ----- O<sub>2</sub> + NO<sub>2</sub>)

# The problem of PM

## PM10 ESPAÑA 2006-2009

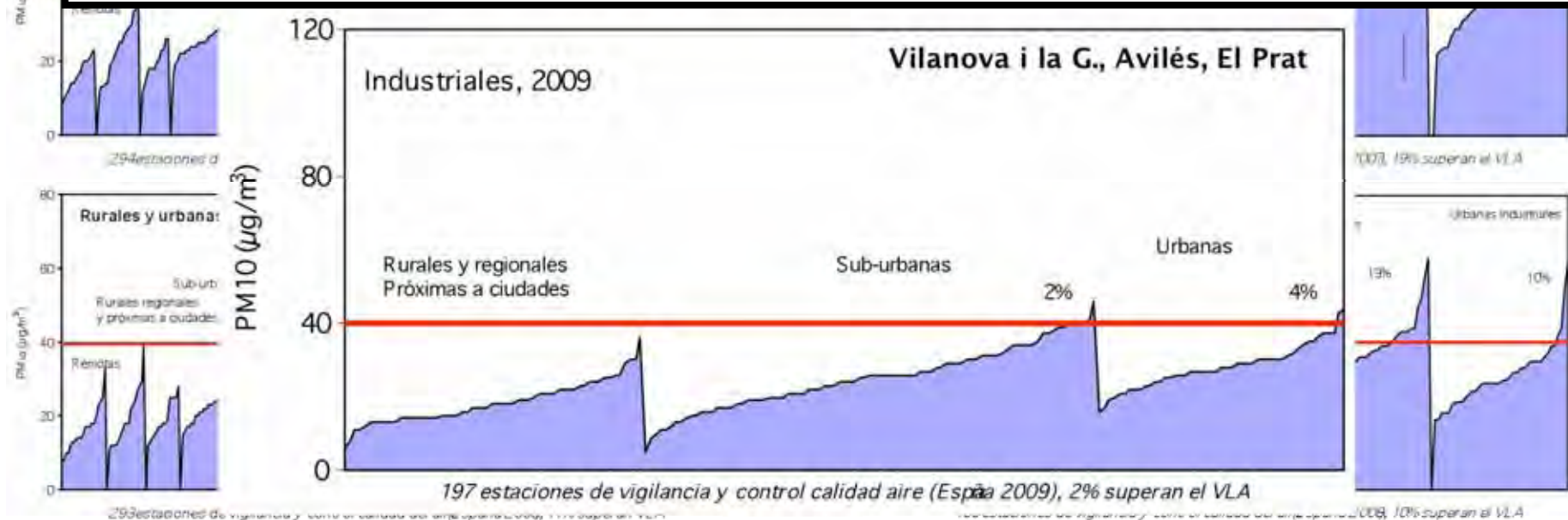


Superaciones\* en 2010

VLA: Avilés2, Avilés3

VLD: Torrejón, Alcalá, Murcia, Aviles1, Avilés2, Avilés 3, Gijón, Camargo, Puertollano

\*sin descuentos africanos

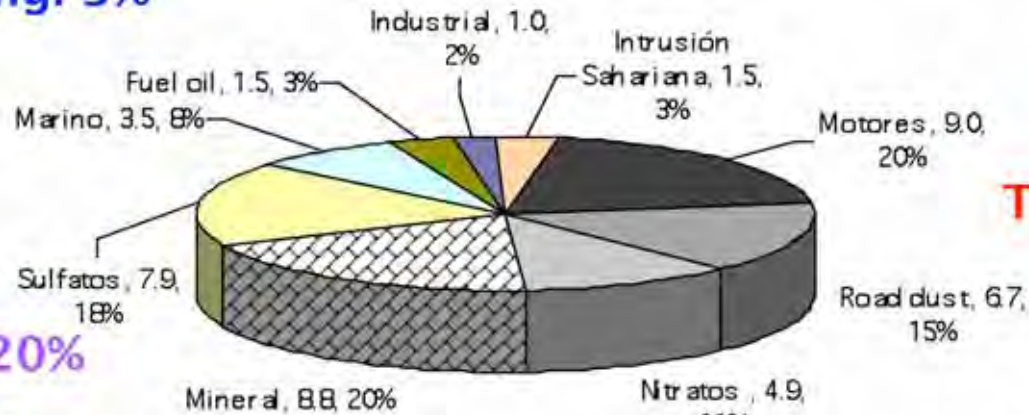


# The problem of PM

## Annual source contributions in Barcelona

### PM<sub>10</sub>

Max.  
Shipping: 3%



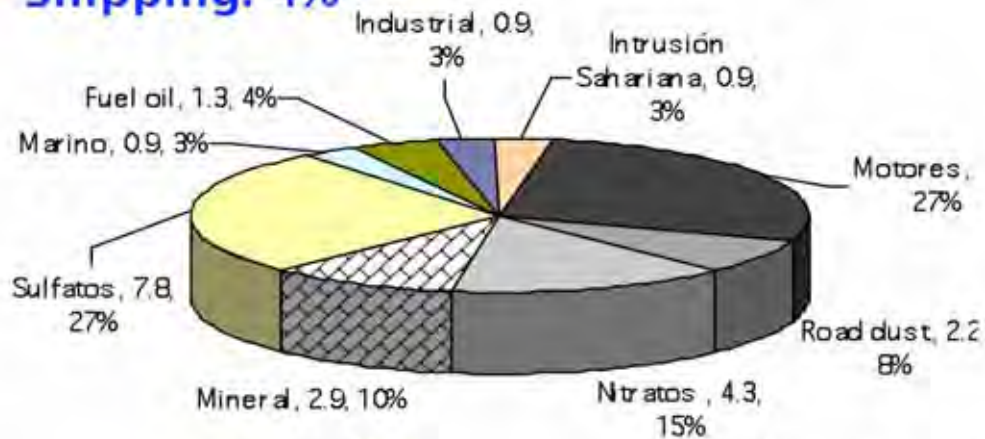
Traffic: 43%

Dem.-res. (reg.): 20%

Max.  
Shipping: 4%

### PM<sub>2.5</sub>

Traffic: 46%

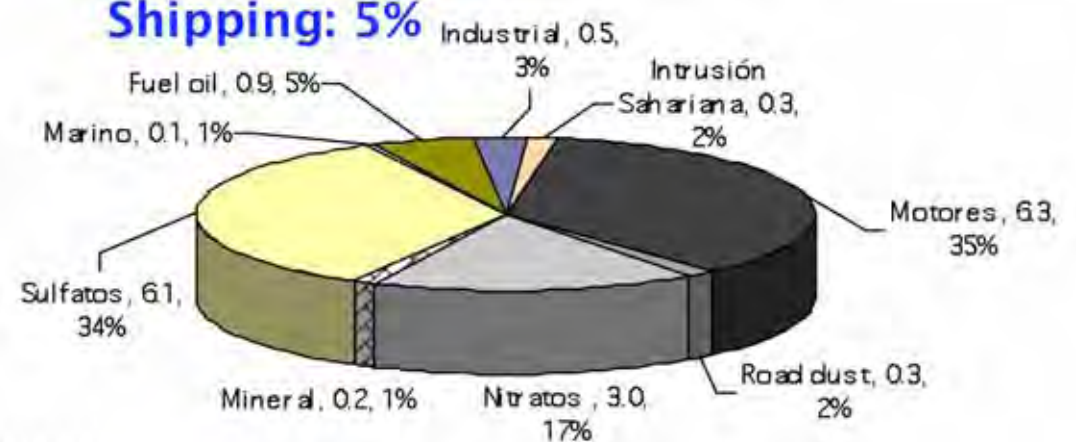


Demolition-resuspension (reg.): 10%

Max.  
Shipping: 5%

### PM<sub>1</sub>

Traffic: 50%

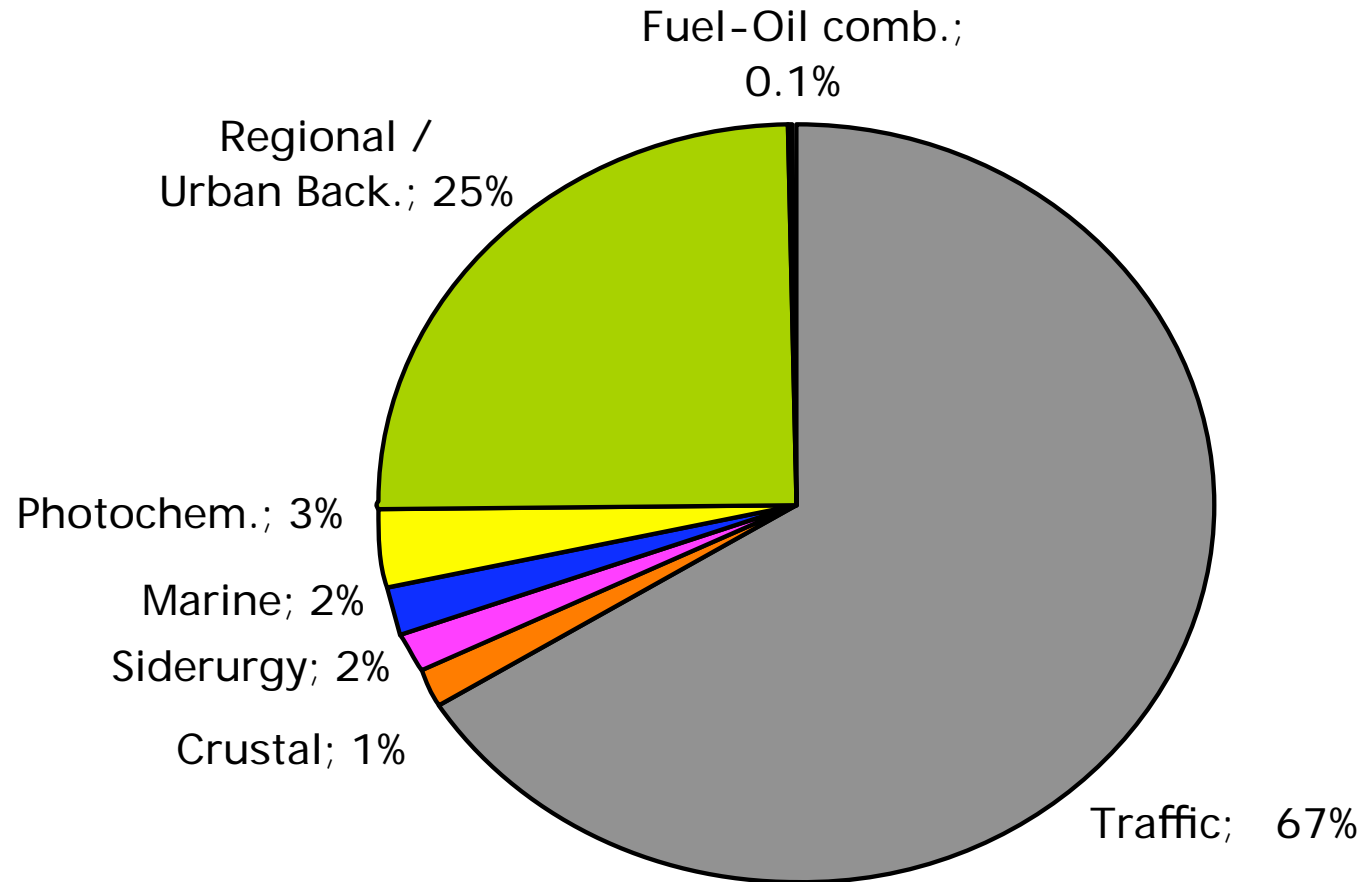


Demolition-resuspension (reg.): 1%

# The problem of PM

## Receptor modelling for **ultrafine particles**

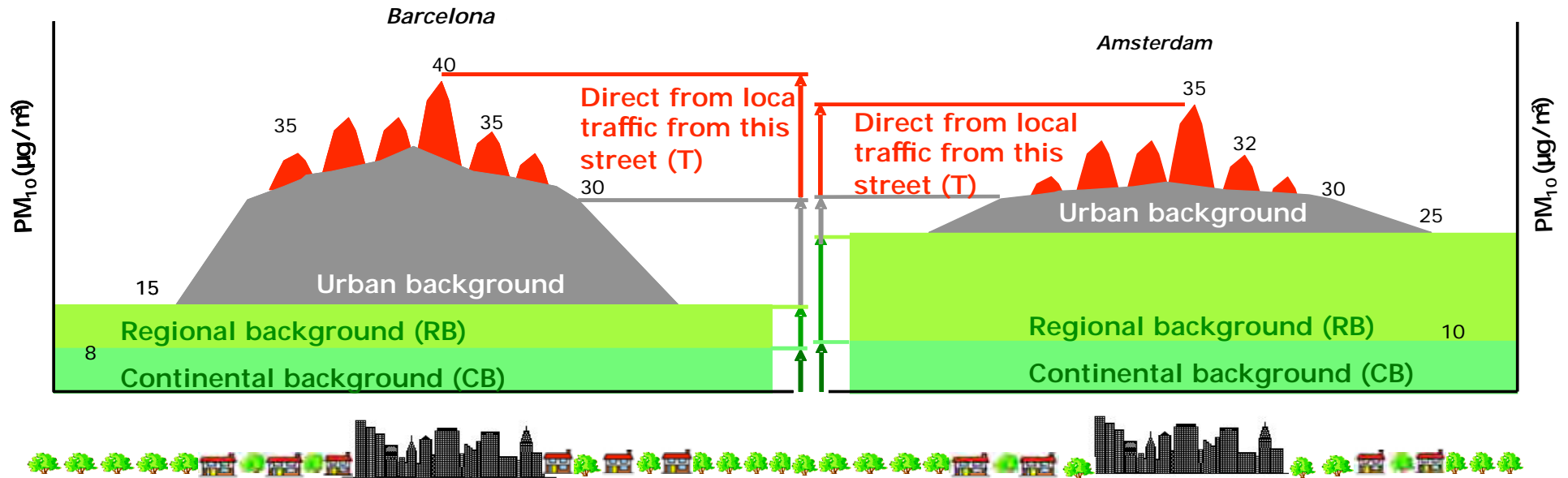
Source contribution to the mean annual  $10^{-800}$



*Pey J., et al. 2009. Atmospheric Environment*

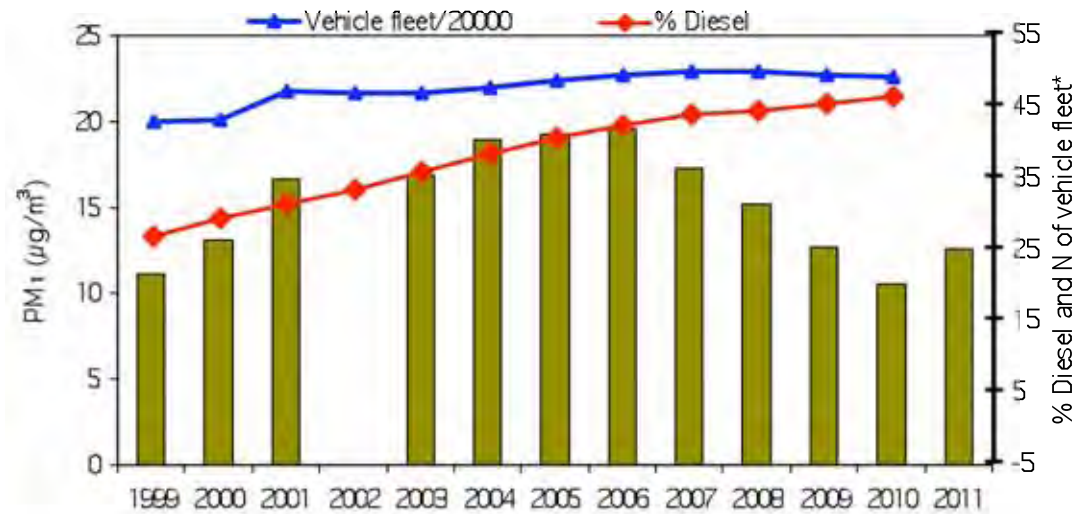
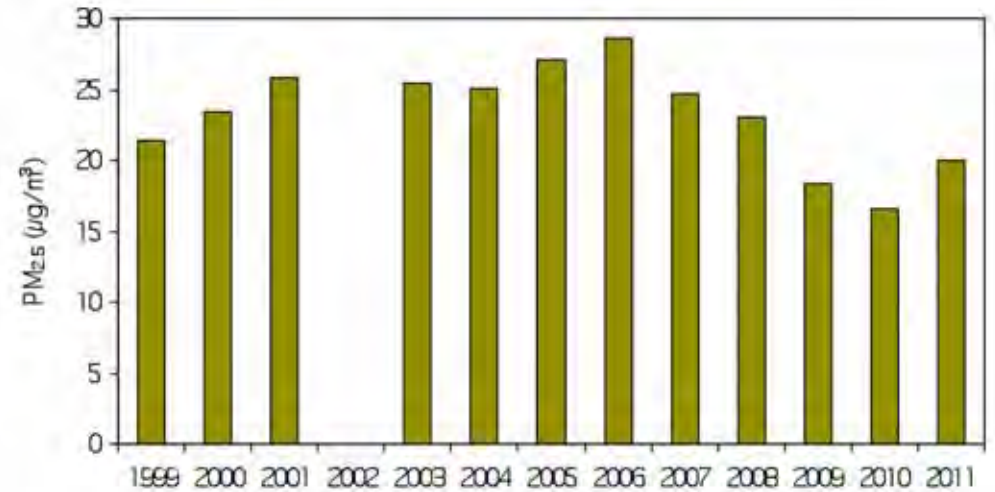
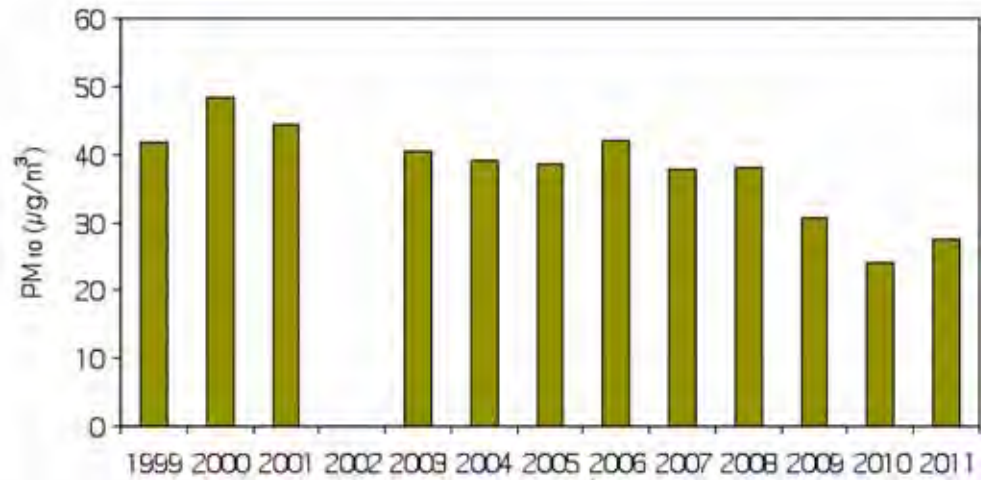
# The problem of PM

PM: IS SIMILAR THE PROBLEM IN ALL THE EU CITIES?



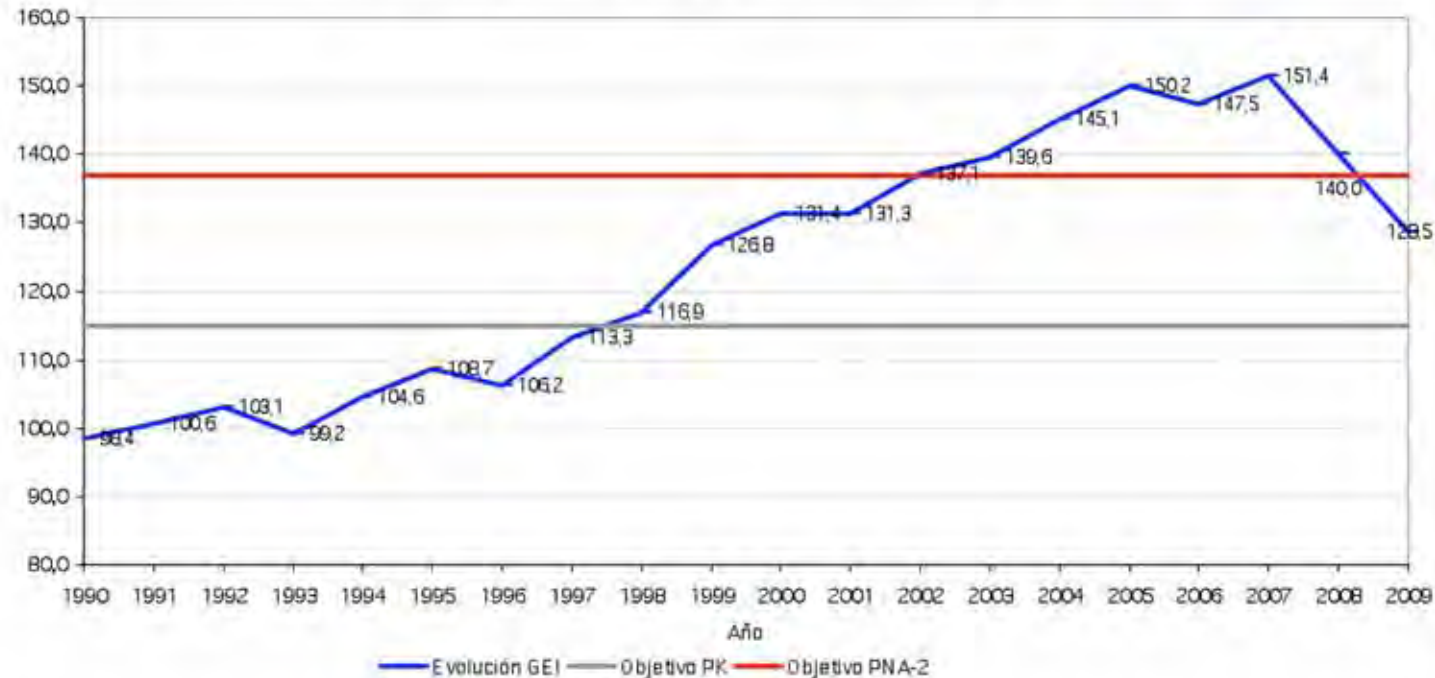
# The problem of PM

## BARCELONA 1999-2011 PM10, PM2.5, PM1



## Green house gases (CO<sub>2</sub> eq.)

Situación respecto al año base Protocolo Kioto





# Scientific and technical bases for air quality plans in Spain

## 1. Measures for road traffic

## 2. Measures for farming

- 2.1. Ammonia emissions
- 2.2. Biomass burning
- 2.3. Agricultural dust

## 3. Measures for construction

- 2.1. Dust from works
- 2.2. Transport of powdered materials
- 2.3. On-road and off-road vehicle emissions
- 2.4. Storage of materials and demolition

## 4. Measures for industry

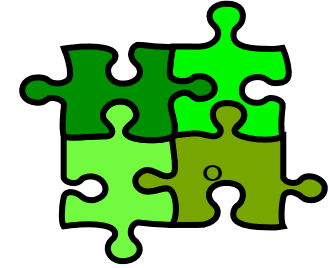
## 5. Measures for harbors

## 6. Measures for airports

## 7. Domestic & residential

# Scientific and technical bases for air quality plans in Spain

## Sources of information



### Road Traffic

- Conference on Air Quality Plans Ecofira, Valencia 17 -18/02/2011
- Report on possible reduction of vehicles in Barcelona, Ajuntament de Barcelona.
- Conference on NO<sub>2</sub> Plans & Programs, Bruselas, 14-15/04/2010
- Nagl C., Moosmann L., Schneider J. (2007). Assessment of plans and programs reported under 1996/62/EC – final report. European Commission, DG Environment Contract No. 070402/2005/421167/MAR/C1. REPORT REP-0079. Vienna, Umweltbundesamt GMBH.
- *El tráfico Rodado y la calidad del aire (2006)*. Fundación Gas Natural. ISBN-13: 978-84-611-4157-9; ISBN-10:84-611-4157-1.
- Two reports from the PM Expert Grup, Geneva Convention, UNECE: *Technical measures to reduce particulate matter emissions of the transport sector*, & *Non-technical measures to reduce transport-related particle emissions*.
- *Future diesel: Exhaust gas legislation for passenger cars, light duty commercial vehicles, and heavy duty vehicles. Upgrading limit values for diesel vehicles*. Umwelt Bundes Amt für Mensch und Umwelt. Federal Agency, July 2003. Stefan Rodt UBA section I.3.2.
- *Clean Diesel Technology: Progress and Potential*. Allen Schaeffer. May 2004, Environmental Monitoring p 19-28.
- *11 Position Paper on PM de EC*. Clean Air For Europe (CAFE). D.G. Environment.

### Construction & demolition

- Guide to air quality assessment in Sacramento County (Sacramento metropolitan Air Quality management Distric, CEQA Guide 2009.
- Best practices for the reduction of air emissions from construction and demolition activities. Environment Canada, Transboundary Issues Branco. March 2005.
- Directive 2003/18/EC for protection to asbestos.
- Guidance for Construction Workks Regional Government from Styria, Austria. www.feinstaub.steiermark.at. 2006.
- Stäubli, A., Kropf, R. 2004. Air pollution control at construction sites – construction guideline air. Environment in practice. Swiss Agency for the Environment, Forests and Landscape BUWAL, Bern.
- Best Practice Guidance. The control of dust and emissions from construction and demolition. Greater London Authority. November 2006.

### Farming

- *Guidance document on control techniques for preventing and abating emissions of ammonia* del United Nations (UNECE, 2007).
- BREF (IPPC):  
*Reference Document on Best Available Techniques for Intensive Rearing of Poultry and Pigs (BREF-ILF, July 2003)*: BREF Reference Document on Best Available Techniques in the Slaughterhouses and Animal By-products Industries (BREF-SA, May 2005):

# Scientific and technical bases for air quality plans in Spain

## ROAD TRAFFIC

### GENERAL

1. Development of Air Quality Plans at a metropolitan scale and not only at the municipal level
2. Awareness and information campaigns to the public should precede all measures
3. Designing plans based on studies on receptors and not only on emission inventories
4. Promoting sustainable mobility plans in companies and labor agreements

### FIRST PRIORITY

5. Improving public transport to meet transport needs both for urban and inter-urban commuting
  - Increased frequency and electric transportation by rail
  - Improved spatial coverage of the lines
  - Economic incentives and combined tickets for different modes of transport
  - Energy efficient design of the network. The radial structure increases by about 20-30% the number of miles flown and denser emissions in central areas
  - Inter-urban bus lanes
  - Applying technological measures (see later)
6. Policy for fuel, road and plate taxation vehicles to reduce the % diesel passenger vehicles
7. Incorporate into ITV OBD emission criteria for NO<sub>2</sub> and PM to detect high polluting vehicles

# Scientific and technical bases for air quality plans in Spain

## ROAD TRAFFIC

### FIRST PRIORITY (continuation)

8. 'Urban Zones of Protected Atmosphere (*Zonas Urbanas de Atmósfera Protegida*; ZUAP)' progressively reducing emissions and limiting movement to polluting vehicles and number of cars.

8.1. Campaigns for public awareness and public transport

8.2. Limitations for polluting cars:



1 Diesel EURO 0 a EURO 2, gasolina Euro 0 y todos los anteriores a 1992 (sin acceso a ZUAP, 01/01/2012)

2 Diesel EURO 2 con filtro de partículas y EURO3 (2013, o 2015)

3 Diesel EURO 3 con filtro de partículas, EURO4 o EURO5. Gasolina Euro 1 con convertidor catalítico

4 Diesel EURO 6, todos gasolina, con el requerimiento mínimo de Euro 2.

Híbridos, gas y eléctricos

8.3. Parking regulation:

- All ZUAP with green parking (different fare for residents)
- Also in are surrounding ZUAP with gradual fare according distance
- Ride car parks (free) sites in large periphery public transport stations
- Free parking for **4+** vehicles
- Longer and larger parking areas fro **4 and 4+** commercial vehicles

8.4. Clean public transport (see later)

8.5. Clean public vehicle fleet: City waste, gardening, cleaning, ... (see later)

8.6. Coal and biomass domestic heating not allowed



# Scientific and technical bases for air quality plans in Spain

## ROAD TRAFFIC

### FIRST PRIORITY (continuation)

9. NO<sub>2</sub>: Anticipate EURO6 for diesel (entering into force in 2015) or requesting an intermediate standard (including for public fleets): EEV (Enhanced Environmental-Friendly Vehicles)
10. HVL (High vehicle lanes) – Bus lanes for inter-urban metropolitan roads
11. 'Plan E' or 'Plan Prever' to promote eco-fleet renewal
12. Increased extension of pedestrian zones in downtown areas
13. Short action plans:
  - 13.1. Implemented when daily & hourly limit value exceedances are anticipated: Using proposed vehicle eco-labeling (1 to 4+) to limit circulation
  - 13.2. Commercial goods and works transport limited to nighttime
14. Long term strategies
  - 14.1. Create public transport infrastructure in parallel to the peripheral urban growth
  - 14.2. Locate future urban logistical structures on education, hospitals, day care, located in areas with better air quality, or act on the traffic around.

# Scientific and technical bases for air quality plans in Spain

## ADDITIONAL MEASURES

## ROAD TRAFFIC

15. Technological measures

15.1. New vehicles, natural gas (SCR), stop & go, hybrid, plugged hybrid, HÍBRIDBUS, electric, hydrogen

15.2. New engines, EGR, fuel injection, high pressure, combustion optimization

15.3. Quality of fuel and lubricants, gasoline, diesel, S content, natural gas, bio - fuel

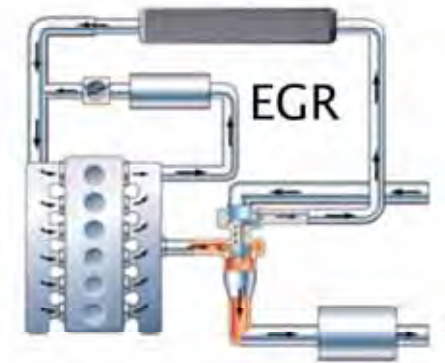
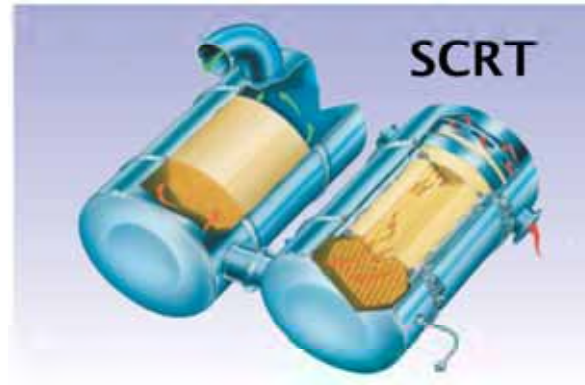
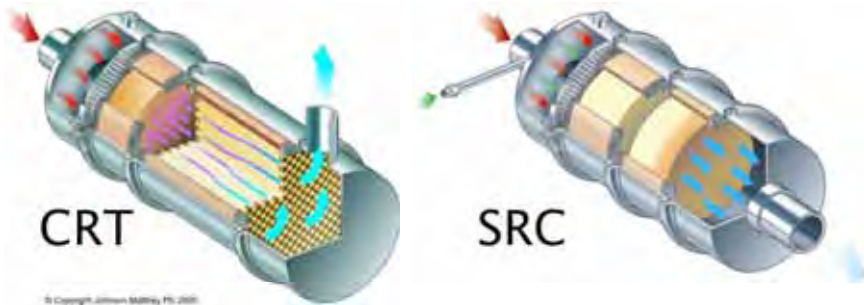
15.4. Limiting metals in lubricants (lubricant diesel ZnO)

15.5 Post-treatment of emissions:

15.6 SRC, OC Systems, L-NOxC,

15.7. PM filters, CRT type (SRCRT), FAP, DPF

15.8. Combination of EGR-FP-SRC (ex. Toyota DPNR)



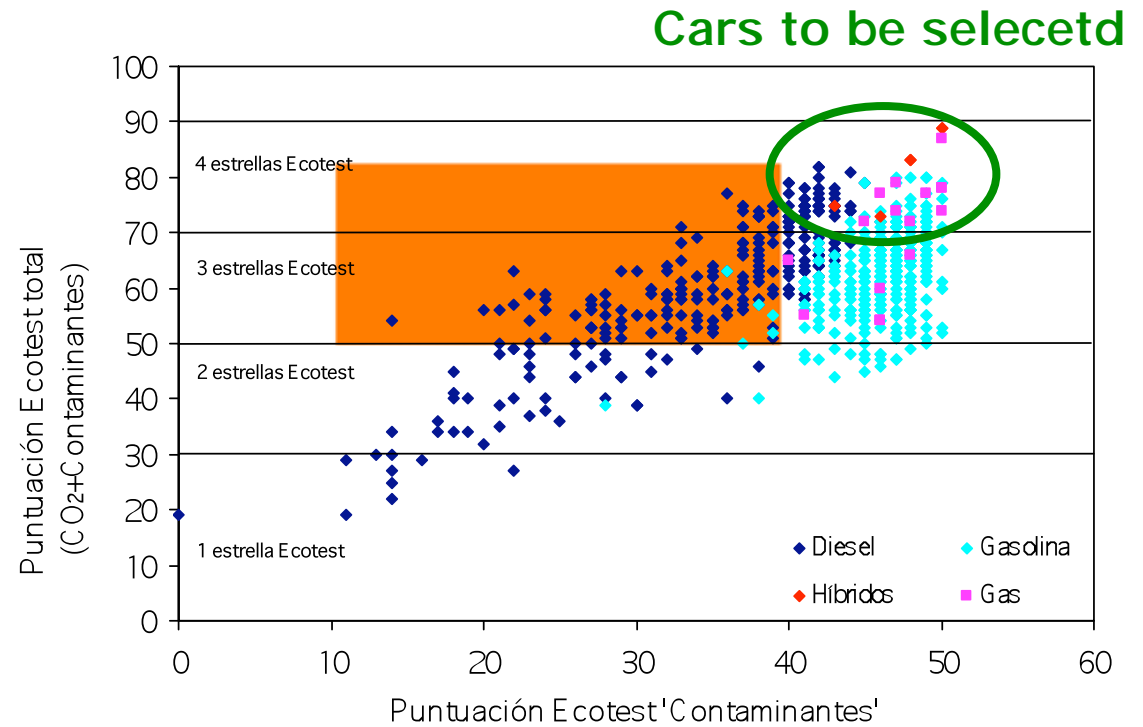
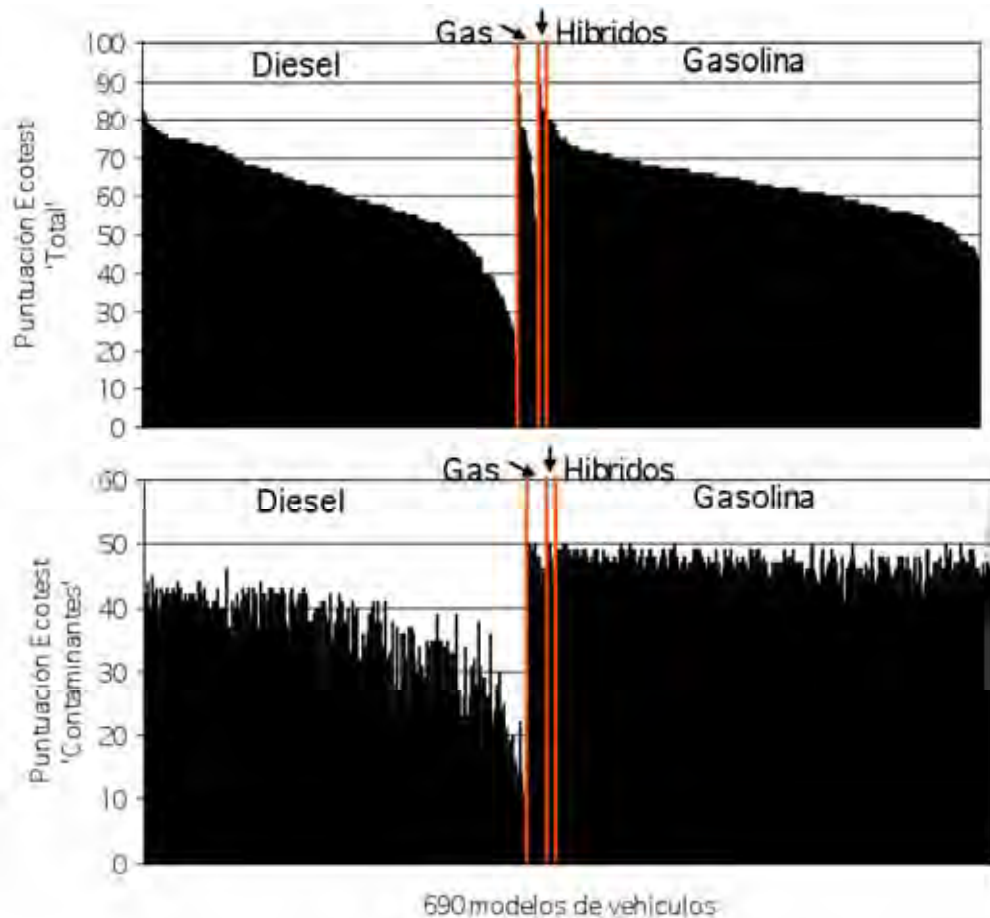
**Current technology fails to reduce abrasion or metal PM brakes, wheels and running strong: NON TECHNOLOGY solutions are needed**

# Scientific and technical bases for air quality plans in Spain

## ROAD TRAFFIC

### ADDITIONAL MEASURES

16. Selecting eco-efficient vehicles (private & public fleets)  
- Make compatible climate and air quality needs



# Scientific and technical bases for air quality plans in Spain

## ROAD TRAFFIC

### ADDITIONAL MEASURES

17. Speed limit restrictions and variable speed
18. Promoting of eco-car selection courses on the basis of personal and / or family needs
19. Promotion of eco-driving courses
20. Minimize clogging roads
21. Aspiration and washing out traffic lanes
22. Conditioning road pavement
23. Diversion of traffic in urban areas (short action plans)
25. Systems development 'car sharing' and 'car pooling'
26. Development of "safe school way"





# Scientific and technical bases for air quality plans in Spain

## SYNERGIES AND INTERFERENCE WITH CLIMATE STRATEGIES

### SYNERGIES

- Both strategies will reduce emissions of pollutants
- Environmental social awareness

### INTERFERENCES

#### Air quality on climate

- Abating NO<sub>x</sub> and PM from vehicle engines may involve increasing CO<sub>2</sub> and / or CH<sub>4</sub> (eg regeneration particulate filters, natural gas, gasoline vs diesel...)
- Abating SO<sub>2</sub> may involve increased CO<sub>2</sub> (combustion gas desulfurization)

#### Climate on air quality

- Reducing CO<sub>2</sub> from road traffic may cause a NO<sub>2</sub> & PM increase (eg. favouring diesel engines with low CO<sub>2</sub> mg/km support)
- Bio - diesel may globally re-circulate CO<sub>2</sub>, but also may increase NO<sub>x</sub>
- Supporting biomass burning in urban areas may globally re-circulate CO<sub>2</sub>, but also increase black carbon (BC, PM, PAH,...) emissions

**There is a better public awareness of climate issues, this required climate policy actions, some of them without coordination with air quality strategies!!**

# Conclusions

- Limit and target values of NO<sub>2</sub>, PM10 & PM2.5 are **exceeded**, specially in areas with high road traffic loads. A few specific industrial hotspots register also exceedances
- The climate and urban architecture of Spanish cities favor accumulation of pollutants and consequently **special measures** are needed

## NO<sub>2</sub>

- **Urgent** measures are needed to solve the problem. High traffic density, **dieselization** (a high proportion are new!!), and high NO<sub>2</sub> emissions of new **diesel cars** are causing this problem
- **Non technological road traffic measures** (reducing the number of cars in the city centre), such as **ZUAPs** are required for NO<sub>2</sub>

## PM10

- Mineral matter (road and construction dust), carbonaceous PM (exhaust) and nitrate (exhaust reacting with ammonia) are the target components to abate
- Non technological traffic measures are also required for PM
- Technological measures are required but these are less efficient for both pollutants
- Measures on climate & air quality should have synergies and not interferences



Acknowledgements: **Fundació Gas Natural**

Ministry of the Environment of Spain, Ministry of Sciences and Innovation of

Regional AQ monitoring networks: Generalitat Valenciana, Generalitat de Catalunya

Andalucía, Baleares, Canarias, Castilla-León, Castilla la Mancha, Euskadi, Extremadura, Galicia, Madrid, Murcia.

*Thank you for your attention !*

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Fotografía: Observatori  
Fabra



# Scientific and technical bases for air quality plans in Spain

## CONSTRUCTION / DEMOLITION

	Zona de riesgo bajo	Zona de riesgo medio	Zona de riesgo alto
<b>Planificación de obra (PREVENCIÓN)</b>	<ul style="list-style-type: none"> <li>colocación de barreras en el límite de obra,</li> <li>no se realizarán ningún tipo de fuegos,</li> <li>se debe planificar donde se colocarán la maquinaria y las actividades que puedan emitir polvo dentro de la zona de obra situándolas lo más alejadas de posibles receptores</li> </ul>	Como la zona de riesgo bajo más: <ul style="list-style-type: none"> <li>designar un responsable de obra,</li> <li>pavimentar entradas y salidas de la obra donde los materiales van a ser transportados</li> </ul>	Como la zona de riesgo medio más: <ul style="list-style-type: none"> <li>utilizar el ferrocarril local para el transporte de material,</li> <li>poner equipos de monitorización en tiempo real de PM,</li> <li>toma de material sedimentable en lugares seleccionados dentro y fuera de la obra</li> </ul>
<b>Tráfico</b>	<ul style="list-style-type: none"> <li>todos los vehículos deben apagar motores cuando no estén trabajando,</li> <li>todos los vehículos deben lavarse antes de dejar la obra,</li> <li>todas las cargas de camiones deben cubrirse,</li> <li>utilizar combustible con bajo % azufre</li> </ul>	Como la zona de riesgo bajo más: <ul style="list-style-type: none"> <li>pavimentar entradas y salidas de la obra,</li> <li>establecer una velocidad límite en la zona.</li> </ul>	Como la zona de riesgo medio más: <ul style="list-style-type: none"> <li>minimizar el tráfico de construcción en la zona de obra,</li> <li>llevar un control de toda la información relativa a los vehículos que entran y salen de la obra.</li> </ul>
<b>Demolición</b>	<ul style="list-style-type: none"> <li>deberá utilizarse agua para evitar la resuspensión de polvo,</li> <li>los equipos para corte de material deben aplicar agua también,</li> <li>se debe minimizar la altura desde la que se derrumban los materiales.</li> </ul>	Como la zona de riesgo bajo más: <ul style="list-style-type: none"> <li>cubrir edificios que se vayan a demoler.</li> </ul>	Como la zona de riesgo medio.
<b>Actividades en la zona</b>	<ul style="list-style-type: none"> <li>minimizar las actividades emitan polvo,</li> <li>regar la zona frecuentemente,</li> <li>mantener el apilamiento de material el menos tiempo posible.</li> <li>Lavar los camiones (no solo las ruedas) con agua a presión</li> </ul>	Como la zona de bajo riesgo más: <ul style="list-style-type: none"> <li>cubrir los apilamientos de material.</li> </ul>	Como la zona de riesgo medio más: <ul style="list-style-type: none"> <li>cubrir con vegetación las zonas expuestas a erosión,</li> <li>levantar barreras contra el viento (árboles, tierra) de la misma altura que los apilamientos.</li> </ul>

# Scientific and technical bases for air quality plans in Spain

## FARMING

Actividad	Medida	Reducción
<b>Quema de biomasa</b>	Prevención (control por autoridades)	-
	Triturado <i>in situ</i> de residuos	85%*
	Valorización de residuos	85%*
	Campañas de información	-
<b>Aplicación de fertilizantes</b>	Aplicación con manguera	30%**
	Aplicación con arrastre rastrillo	60%**
	Inyección en surco abierto	70%**
	Inyección en surco cerrado	80%**
	Incorporación de fertilizantes sólidos	80-90%**
<b>Almacenamiento de fertilizantes</b>	Estiércol sólido con suelo impermeable y ventilación	-
	Recubrimiento de estiércol líquido	30-80%**
	Correcta gestión de espacios	-

Actividad	Medida	Red.
<b>Labranza / erosión</b>	Rotación de cultivos todo el año	-
	Siembra de cobertura vegetal	-
	Cobertura del suelo con residuos de cultivo	-
	Irrigación periódica	-
	Aplicación de estabilizadores químicos	-
	Siembra intra-cultivo (hilera)	-
	Utilización de parapetos o cortavientos	-
<b>Tráfico de vehículos agrícolas y ganaderos</b>	Siembra de cultivos que minimicen la erosión	-
	Implementación de catalizadores	-
	Mejora del combustible	-
	Minimización del tiempo <i>al ralentí</i>	-
	Correcto mantenimiento	-
	Optimización de procesos	-
	Asfaltado de vías	-
Campañas de información	-	

\*: Fuente, GVA (2008). \*\*: Fuente, UNECE (2007).

# PARTICULATE MATTER AND HEALTH EFFECTS

## BARCELONA

Perez et al. 2009

### Selected results

Fraction	Respiratory mortality (Lag2)	Cardiovascular mortality (Lag1)	Cerebrovascular mortality (Lag1)
PM <sub>10-2.5</sub>	1.033 (0.980-1.089)	1.059 (1.026-1.094)	1.098 (1.030-1.171)
PM <sub>2.5-1</sub>	1.206 (1.028-1.416)	0.984 (0.892-1.086)	0.905 (0.743-1.102)
PM <sub>1</sub>	1.010 (0.963-1.059)	1.028 (1.000-1.058)	1.063 (1.004-1.124)

Odds ratio per 10 ug/m<sup>3</sup>

# Air Quality problems in EU



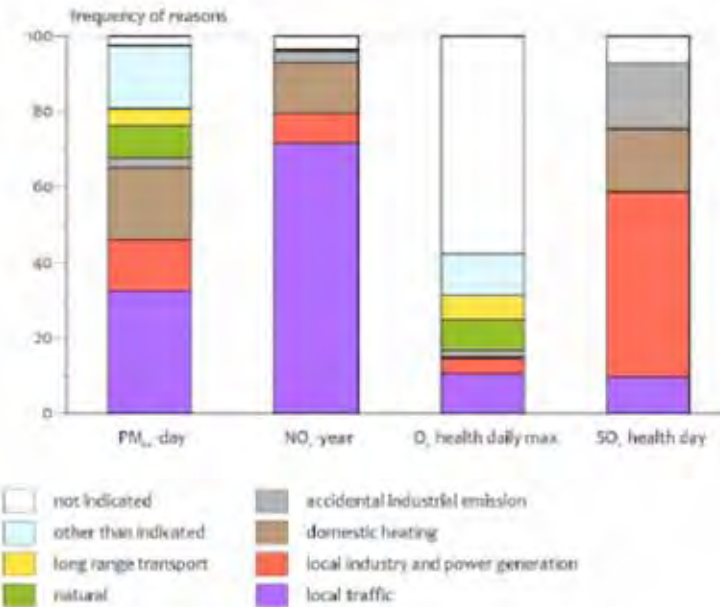
# Critical Air Quality problems in EU

Reporting on ambient air quality assessment  
in the EU Member States, 2008



ETC/ACC Technical Paper 2010/11  
December 2010

*Benno Jimmink, Frank de Leeuw, Erik Noordijk,  
Jana Ostatnická, Markéta Coňková*



\* data extracted from form 11 and 13 of AQ questionnaire

Figure 7: Reported reasons for exceedances of limit and target values of PM<sub>10</sub>, NO<sub>2</sub>, O<sub>3</sub> and SO<sub>2</sub>, 2008



# Critical Air Quality problems in EU

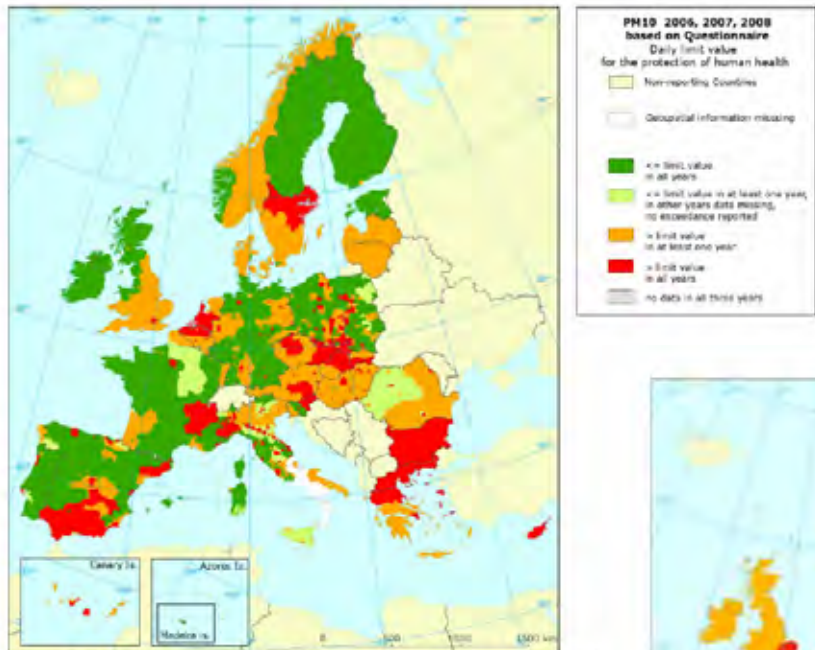
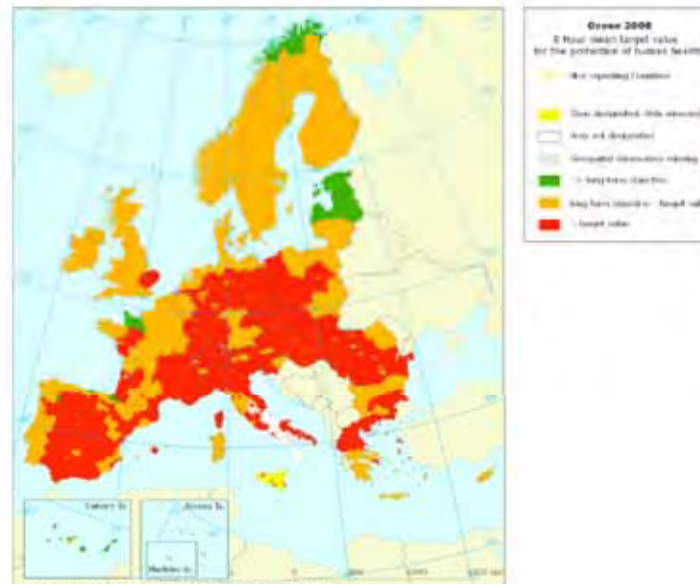
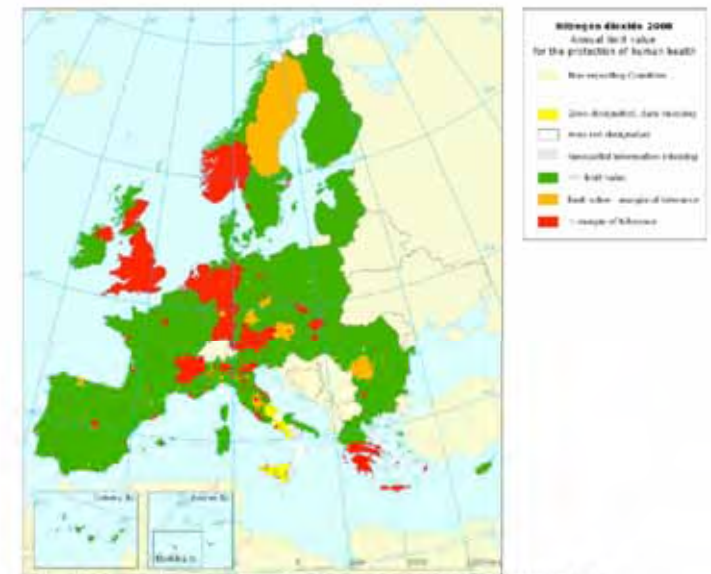


Figure 9. EU27 Exceedances of PM<sub>10</sub> daily limit value, 2006-2008



\*data extracted from form 8 and 9 of AQ questionnaire

Figure 5: EU27 O<sub>3</sub> health zone in exceedance, 2008



**Figure III.5: Zones in exceedance for the annual limit value for NO<sub>2</sub> in 2008.**  
The Netherlands have all their designated zones exceeding the limit value plus margin of tolerance. Germany, UK and Italy have the highest number of zones in exceedance of LV+MOT. The most agglomeration exceedances of the MOT also occur in Germany (28), UK (27) and Italy (25). In Austria, the Czech Republic and the Netherlands all designated agglomerations exceed the LV+MOT. The most mentioned cause mentioned for exceedance of the annual limit value of NO<sub>2</sub> is local traffic (85%). For 33 zones in the United Kingdom and 7 zones in the Netherlands the reported exceedances are based on modelled results.