Evidències científiques de l'impacte dels vehicles dièsel i gasolina en la qualitat de l'aire

(i mesures sobre ells per millorar-la)

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Institut de Diagnosi Ambiental i Estudis de l'Aigua,
IDAEA-CSIC
Environmental Feochemistry & Atmospheric Research (EGAR)

Contingut

- Estat de la contaminació urbana i tendències
- Mesures per millorar qualitat de l'aire a zones urbanes

AIRUSE

LIFE 11 ENV/ES/000584

LIFE AWARD 2018
BEST OF BESTS
GREEN CITY PROJECT
DG ENV
23/05/2018

LIFE11 /ENV/ES/584

AIRUSE

Testing and development of air quality mitigation measures in Southern Europe

ACKNOWLEDGEMENTS

Spain : MAGRAMA, Generalitat Catalunya, Genralitat Valenciana, Barcelona, Madrid, València, L'Alcora City Councils,

Italy: ARPA-Lombardia, Regione Lombardia, Regional Government of Tuscany, ARPA Toscana

Portugal: Porto City Council, North Regional Coord. & DeveloP. Comm. (CCDR-N)

Greece: Ministry of Environment, Energy and Climate Change

http://www.cleanaircities.net/es/

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airuse.eu
cleanaircities.net

Air quality in Europe

KEY POLLUTANTS IN URBAN AIR QUALITY

Table ES.1 **Percentage of the urban population in the EU-28 exposed to air pollutant concentrations above certain EU and WHO reference concentrations (minimum and maximum observed between 2013 and 2015)**

Pollutant	EU reference value ([a])	Exposure estimate (%)
$PM_{2.5}$	Year (25)	7-8
PM_{10}	Day (50)	16-20
O_3	8-hour (120)	7-30
NO_2	Year (40)	7-9
BaP	Year (1)	20-25
SO_2	Day (125)	< 1

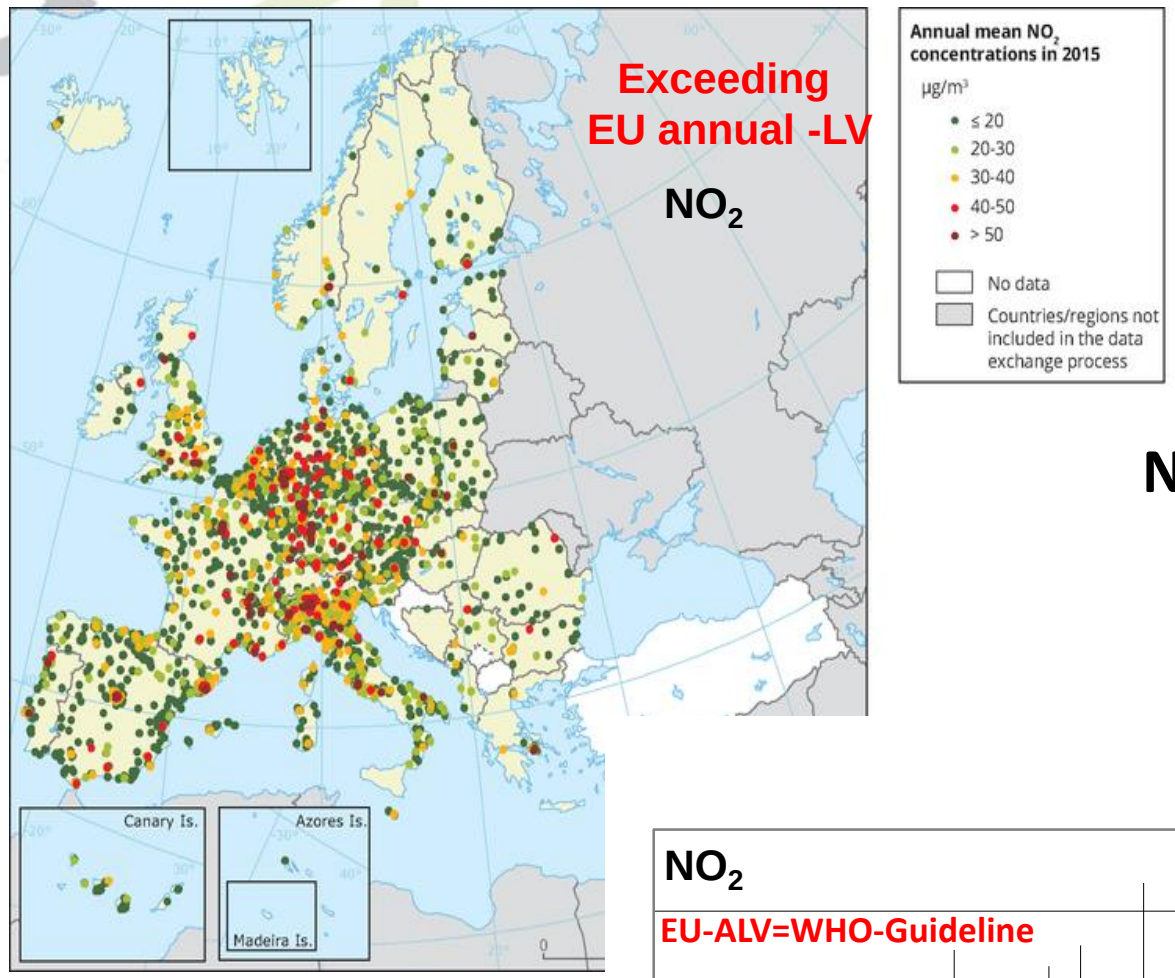
EEA Report / No 13/2017

11/10/2017

European Environment Agency

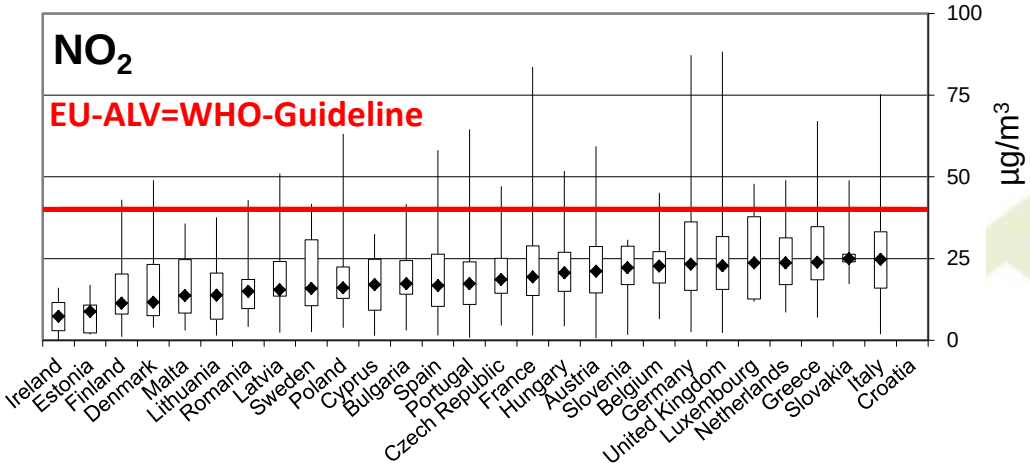
https://www.eea.europa.eu/publications/air-quality-in-europe-2017

The problem of NO_2



NO_2 annual limit value

2015



EEA Report / No 13/2017

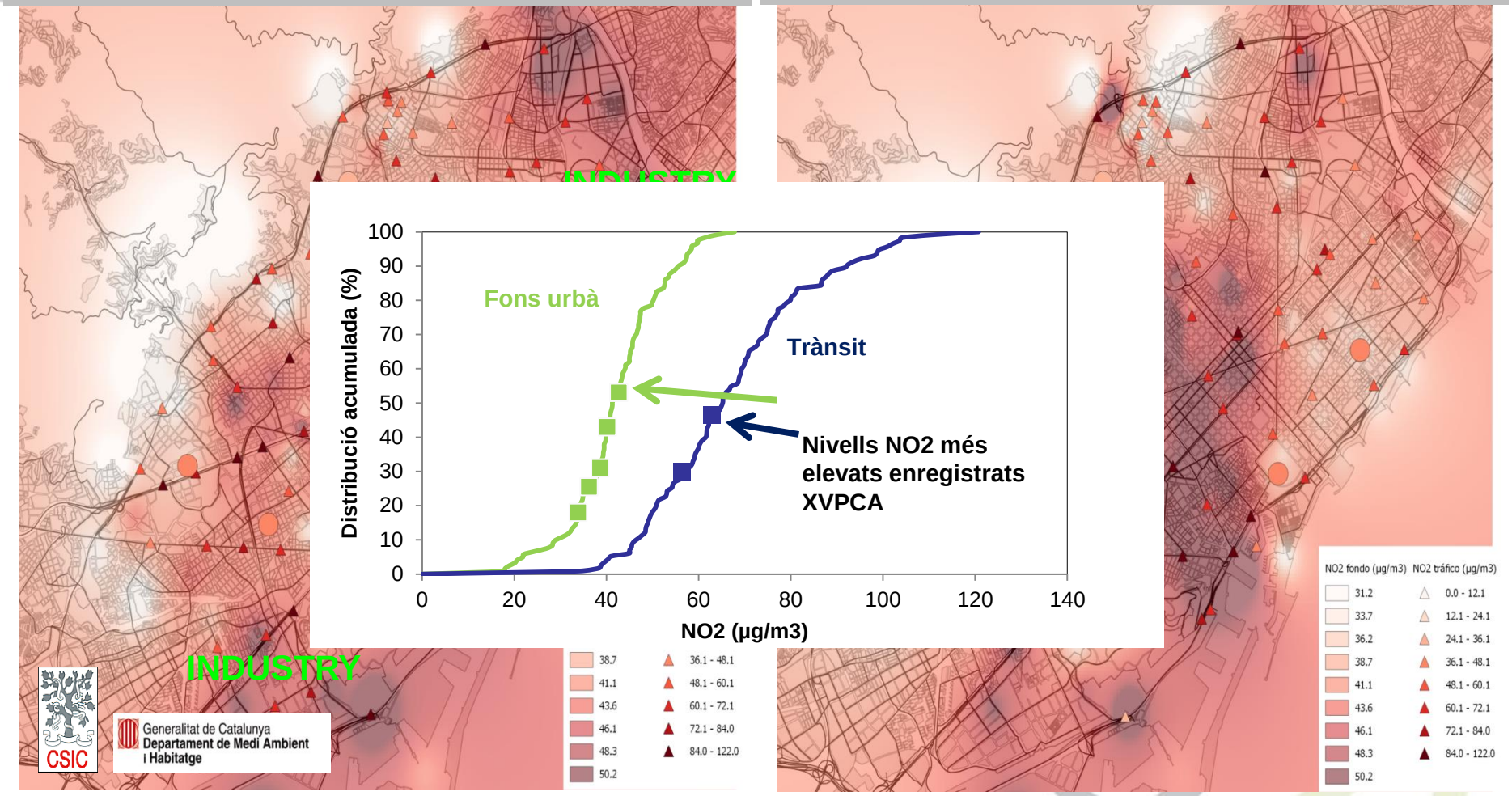
11/10/2017

European Environment Agency

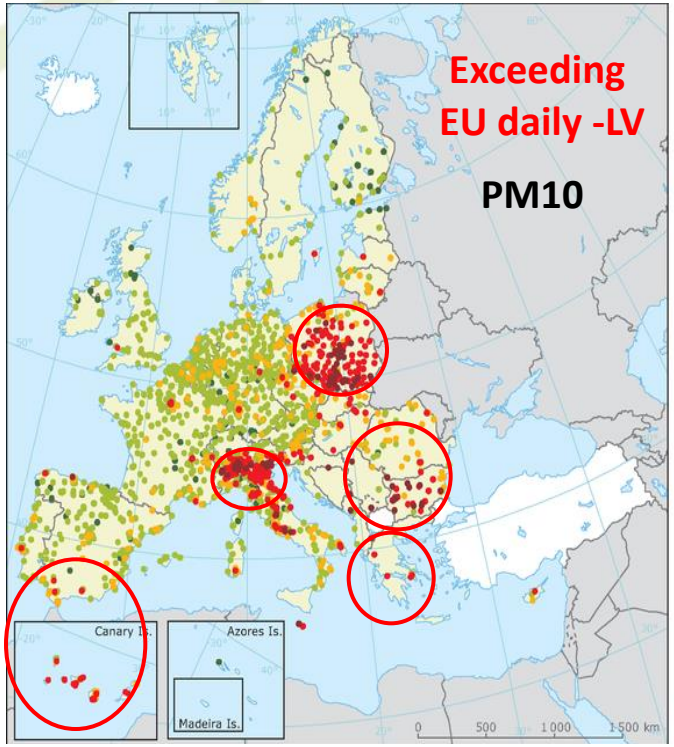
The problem of NO_2

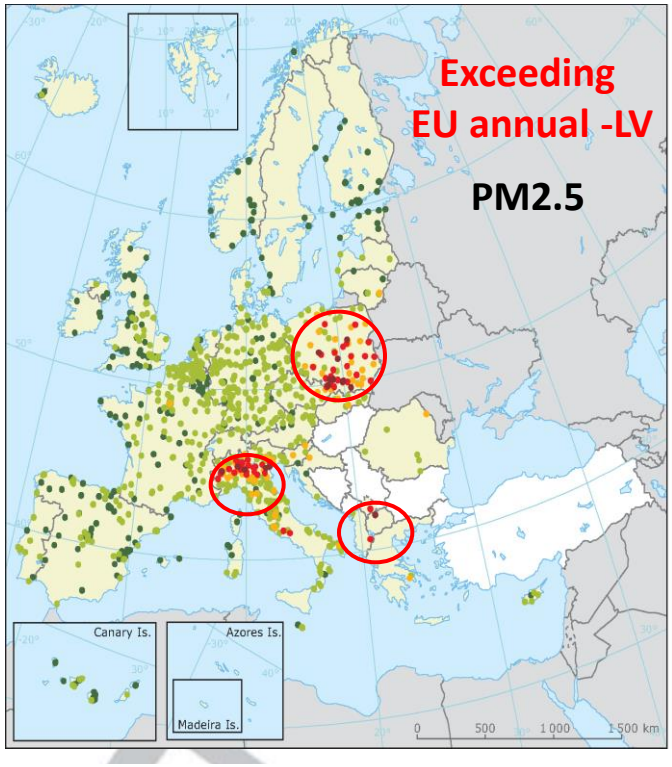
NO_2 FEBRUARY-MARCH 2017, 212 PASSIVE DOSIMETRES

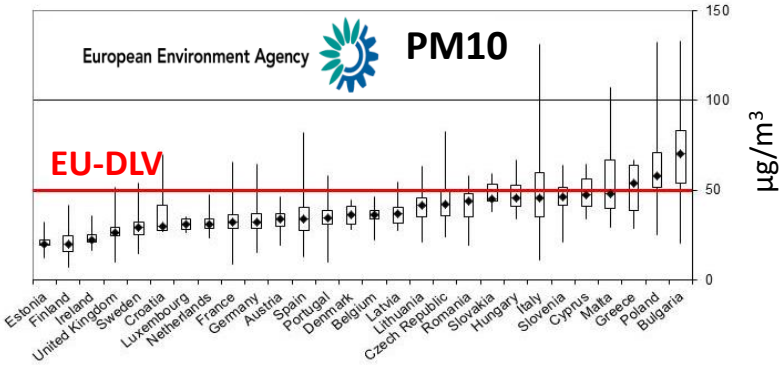
NO_2 JUNE 2018, 212 PASSIVE DOSIMETRES

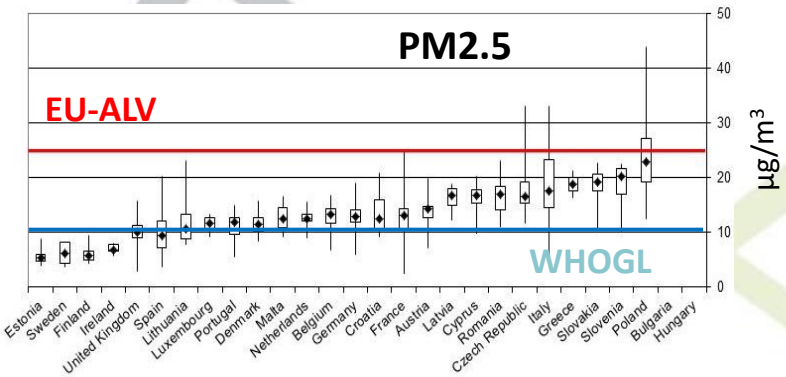


The problem of PM







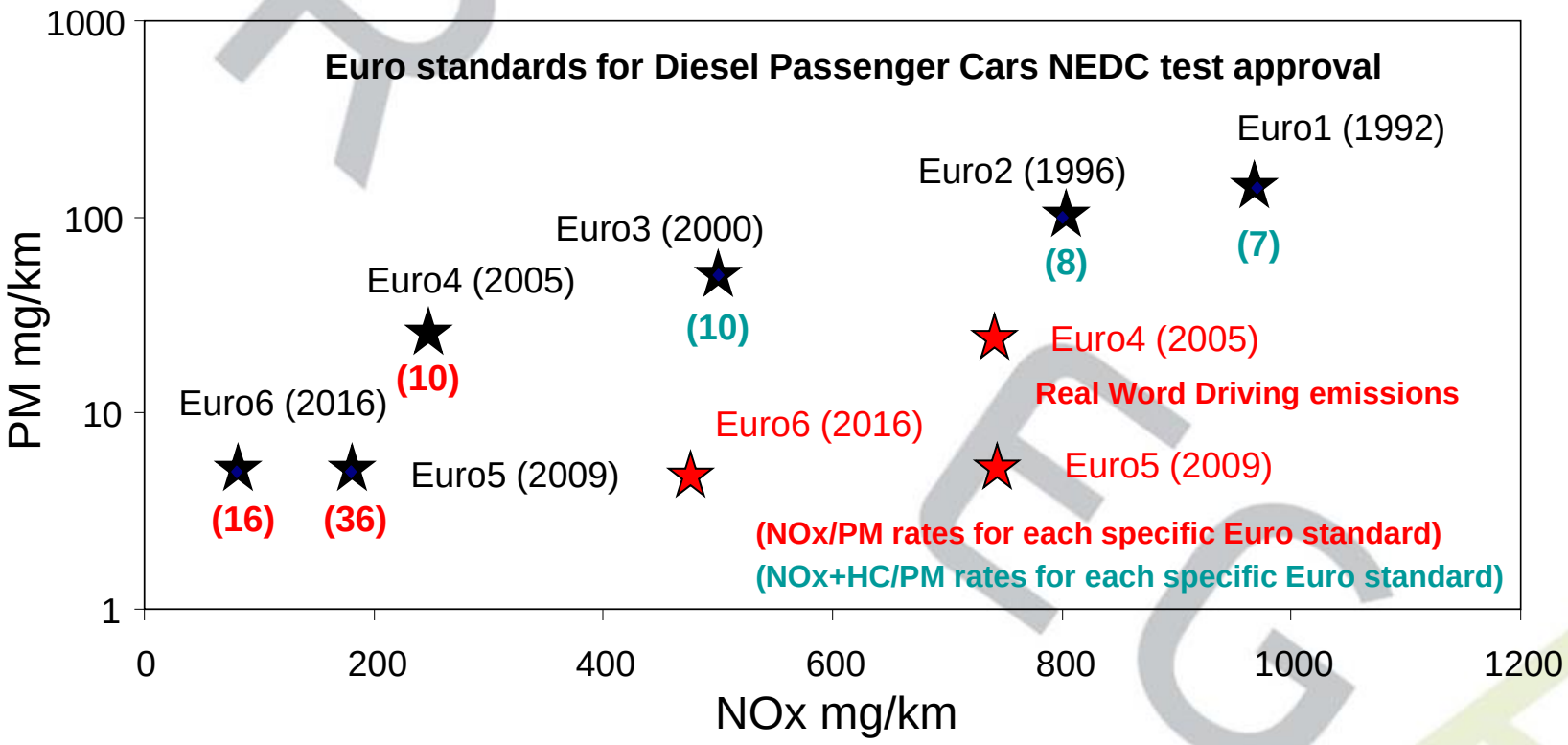


The problem of PM

PM10 (annual mean)	PM10 (days of exceedance)
1. Road Traffic is the main source contributing to PM10: 31-38% (ATH 23%)	36-45% (ATH 15%)
1.1. Vehicle exhaust + traffic related NO_3^- are the main causes: 21-29%	30-34% (ATH 6%)
1.2. Non-exhaust vehicle emissions are also relevant: 8-11%	18-29% (ATH 3%, POR 6%)
2. Regional OC and/or SO_4^{2-} dominated pollution: 20-26% (POR-TR 10%)	BCN 19%, 2-6%
3. Local dust : 10-19%	POR 27%, 1-4%
4. Biomass burning very relevant in POR & FI (14-16%), less in ATH (7%) and negligible	POR & FI (25-30%), ATH 1%, negligible in BCN
5. Industry BCN 11%, 4-5%, ATH <1%	BCN 17%, <1-3%
6. Non traffic-NO_3^- 6-8% (2% POR)	BCN & FI 7-9% (1-2% POR & ATH)
7. Shipping 4% in coastal sites	3-4% in coastal sites
8. African dust ATH 14%, 1-4%	ATH 52%, 1%
9. Sea salt POR 13%, 4-8%	ATH 7%, 1-3%
10. Anthropogenic dust (Local dust + Non exhaust) reaches 19-25%	11-33%, ATH 4%

PM2.5 (annual mean)	PM2.5 (days of PM10 exceedance)
1. Road Traffic is the main source contributing to PM2.5: 28-39% (ATH 22%)	32-42% (ATH 11%)
1.1. Vehicle exhaust + traffic related NO_3^- are the main causes: 25-34% (ATH	31-40% (ATH 10%)
1.2. Non-exhaust vehicle emissions are also relevant: 5-9% (BCN&FI 1-2%)	1-7%
2. Regional OC and/or SO_4^{2-} dominated pollution: 19-37% (POR 13%)	BCN & MLN 11-22%, 2-6%
3. Local dust: POR 16%, 2-6%	POR 22%, 1-2%
4. Biomass burning very relevant in MLN, FI & POR (18-21%), less in ATH (10%) and negligi	POR, FI & MLN (26-33%), <2%
5. Industry 5-12%, ATH <1%	BCN 18%, <1-3%
6. Non traffic-NO_3^- 3-6% (POR 1%)	BCN, FI & MLN 6-9% (1-3% POR & ATH)
7. Shipping 5-7% in coastal sites	6-10% in coastal sites
8. African dust: ATH 6%, <1%	ATH 45%, 1%
9. Sea salt POR 5%, <1-3%,	<1%-1%
10. Anthropogenic dust (Local dust + Non exhaust) reaches 10-21%, BCN 7%, FI 4%	POR 15, 3-9%

The problem of PM



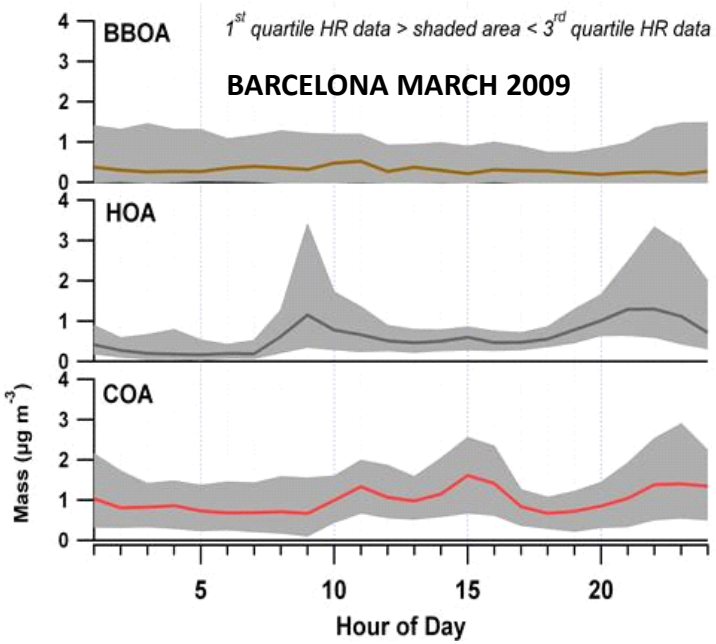
The problem of PM

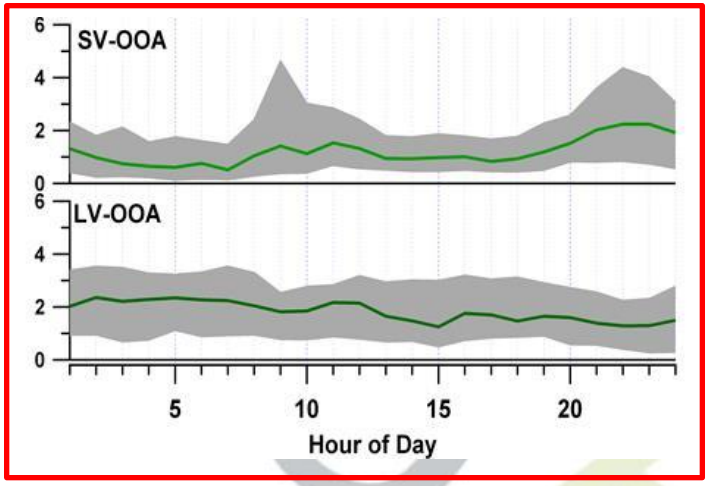
The issue of the origin of organic carbon in PM

- Fossil vs non fossil fuel
- Origin of urban SOA and eBSOA
- High SOA potential of gasoline vs diesel exhaust emissions
- Cooking, biomass burning

Gasoline cars produce more carbonaceous particulate matter than modern filter-equipped diesel cars
Platt I. E et al., Scientific Reports 7, 4926 (2017) doi:10.1038/s41598-017-03714-9

Combination of OC & EC, ^{14}C & aerosol mass spectrometer (AMS)





- Mohr C., et al., 2011, Atmos Chem Phys
- Minguillón et al., 2011, Atmos Chem Phys
- Ripoll et al., 2015, Atmos Chem Phys
- Minguillón et al., 2015, Atmos Chem Phys
- Minguillón et al., 2016, Faraday Discussions

The problem of PM

Volatile chemical products emerging as largest petrochemical source of urban organic emissions

McDonald *et al.*, *Science* **359**, 760–764 (2018) 16 February 2018

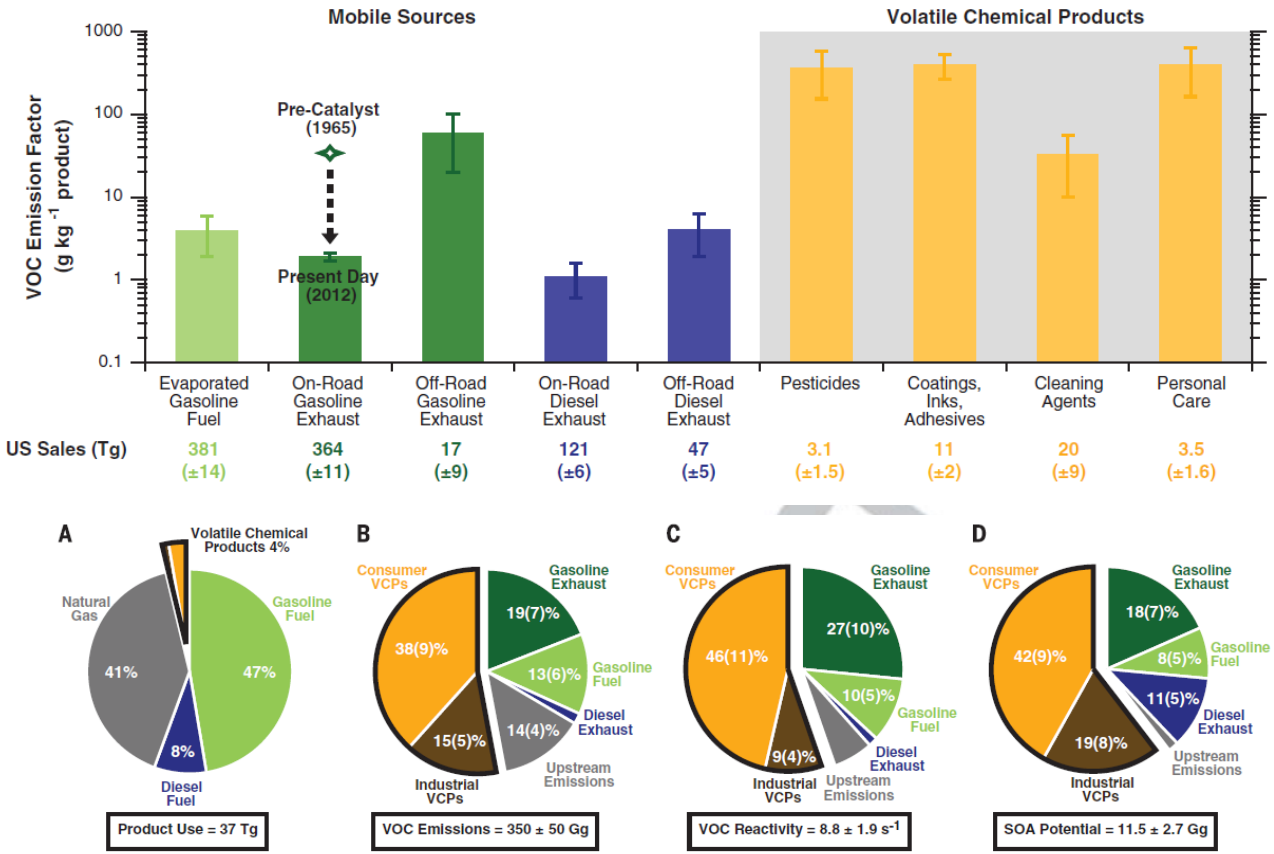
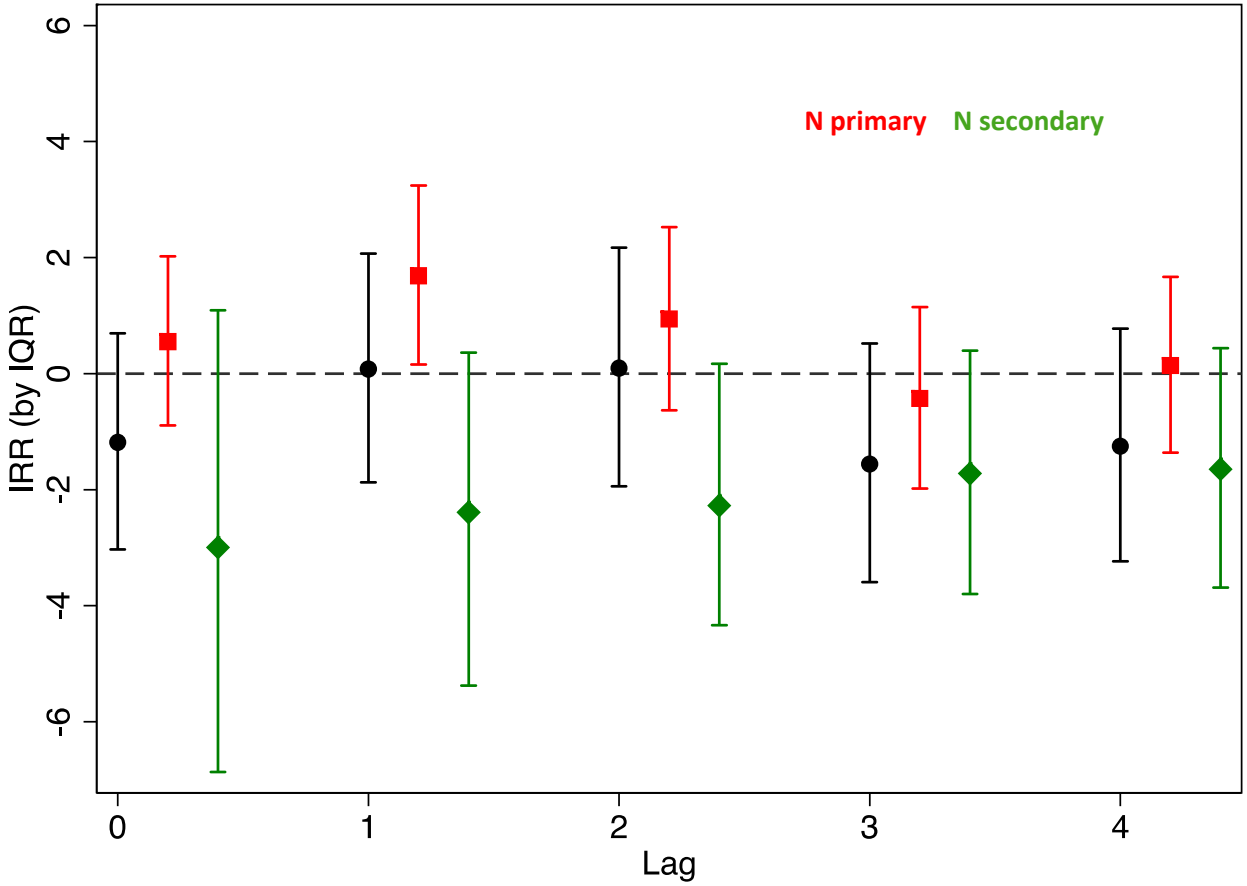


Fig. 4. Contributors to ambient air pollution in Los Angeles. (**A** to **D**) Distribution of (A) petrochemical product use, (B) VOC emissions, (C) VOC reactivity with OH, and (D) SOA formation potential across petrochemical sources only. Contributions from nonfossil sources are not shown. Uncertainties in source apportionment were determined by Monte Carlo analysis.

The problem of PM

Short-term health effects of total, primary and secondary UFP in Barcelona 2009-2011 series total mortality (Tobías A. et al Envir Int, 2018)



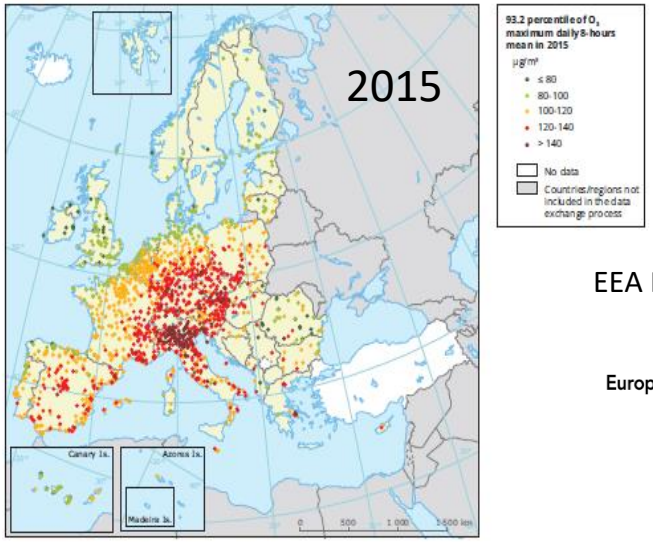
● **N total**
IQR = 7313 ng/cm^3

■ **N primary**
IQR = 3953 ng/cm^3

◆ **N secondary**
IQR = 5749 ng/cm^3

The problem of ozone

O_3, triennial target value



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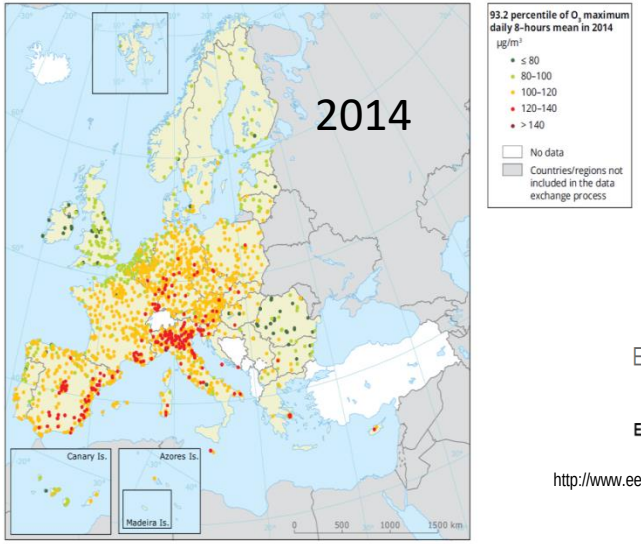
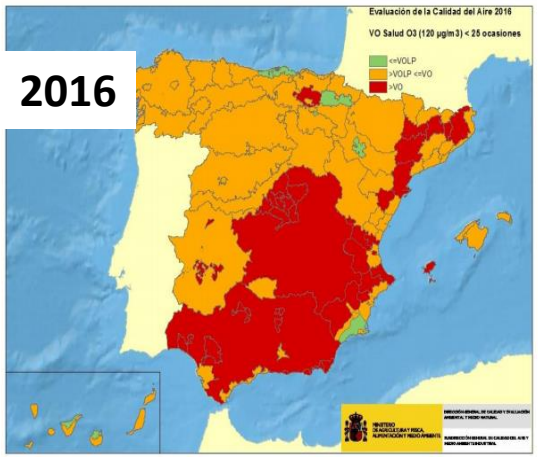
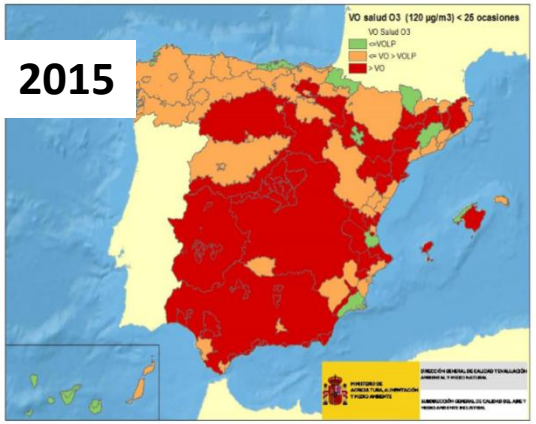


EEA Report | No 28/2016
32/11/2016
European Environment Agency

http://www.eea.europa.eu/publications/air-quality-in-europe-2016





Quines fonts de contaminants urbans tenim a l'AMB?

1. Trànsit rodat
2. Industria
3. Generació elèctrica
4. Construcció i demolició obra pública i privada
5. Agricultura
6. Domèstic i residencial
7. Port i aeroport

Què emet el trànsit?

Total trànsit a Barcelona
35% del PM10 anual, 60% NO_2
45% del PM10 episodis, 70% NO_2

Emissions motor: CO_2, CO, NOx ($NO+NO_2$), PM (EC+HC), UFP, COVs,.

Emissions evaporació dipòsit: COVs

.

25% del PM10 anual
30% del PM10 episodis

Emissions resuspensió: PM (Si, Al, Ca, Fe, K, Na, Cu, Mn, Sb, Zn)

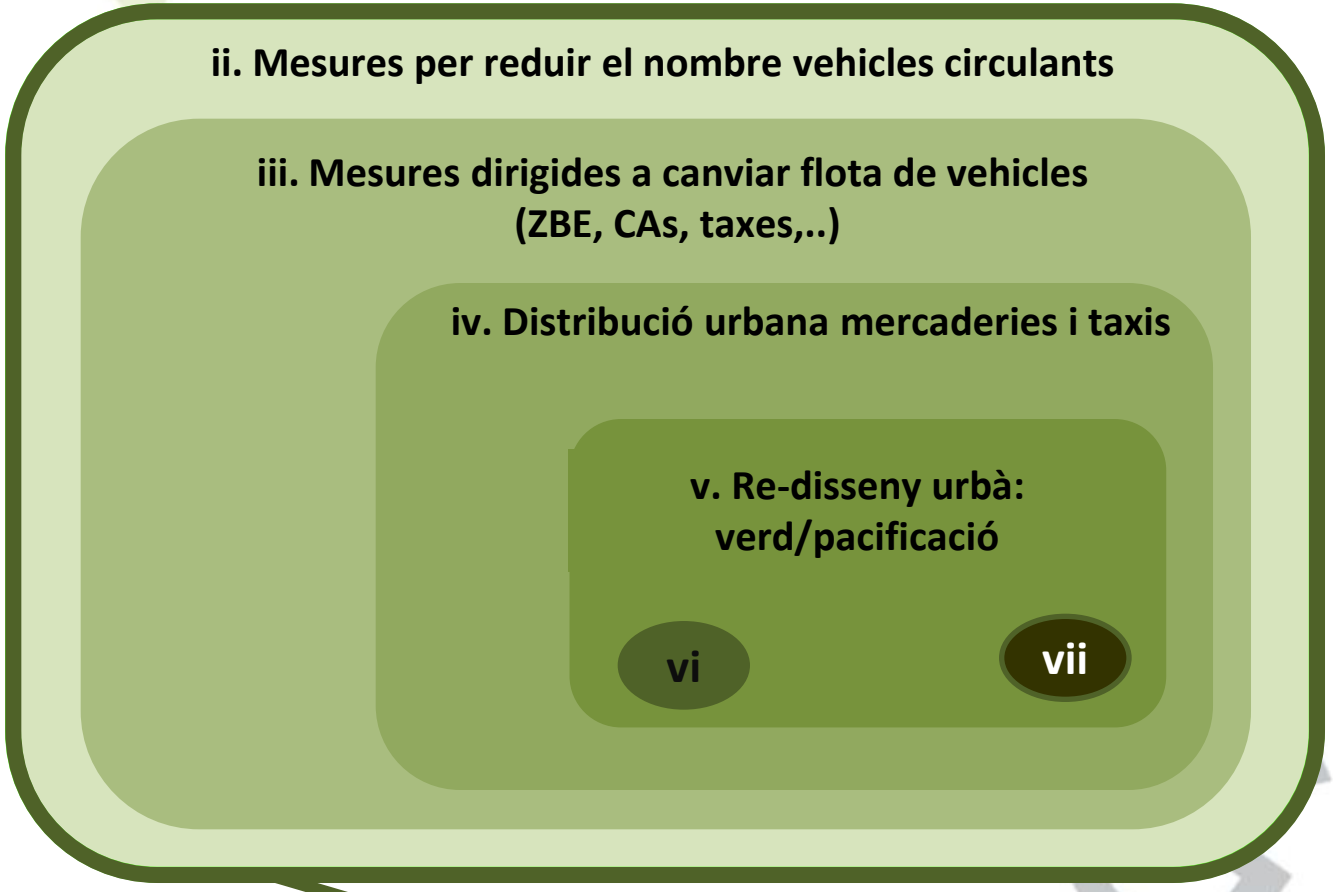
10% del PM10 anual
15% del PM10 episodis

Emissions abrasió rodes: PM (OC, EC, S, Zn)

Emissions abrasió frens: PM (Fe, Mn, EC, Cu, Sb, Sn, Ba,…)

Mesures sobre el trànsit rodat

0. Els Plans de qualitat de l'aire cal fer-los a nivell metropolità més que municipal

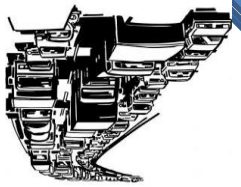


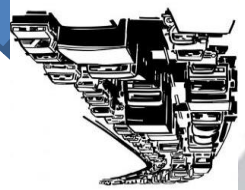
vi. Mesures de remediació
vii. Altres mesures no tecnològiques

i. Millora del transport pùblic

Mesures sobre el trànsit rodat

1. Mesures per reduir vehicles circulants

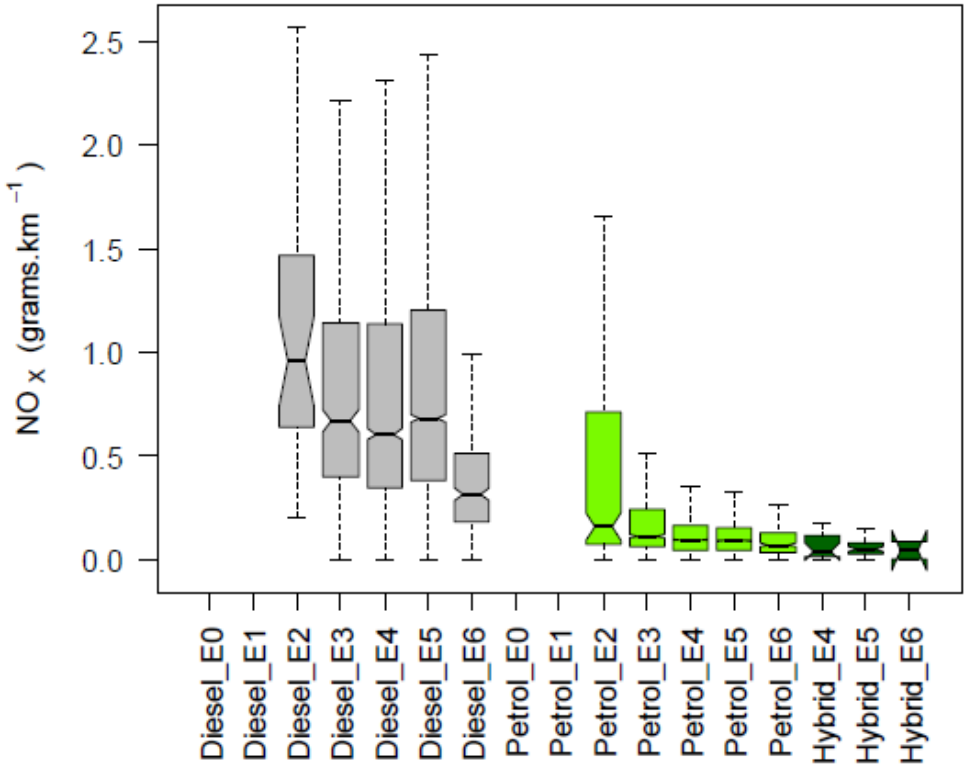




Mesures sobre el trànsit rodat

Euro VI

Passenger cars, Spring/ Summer 2015



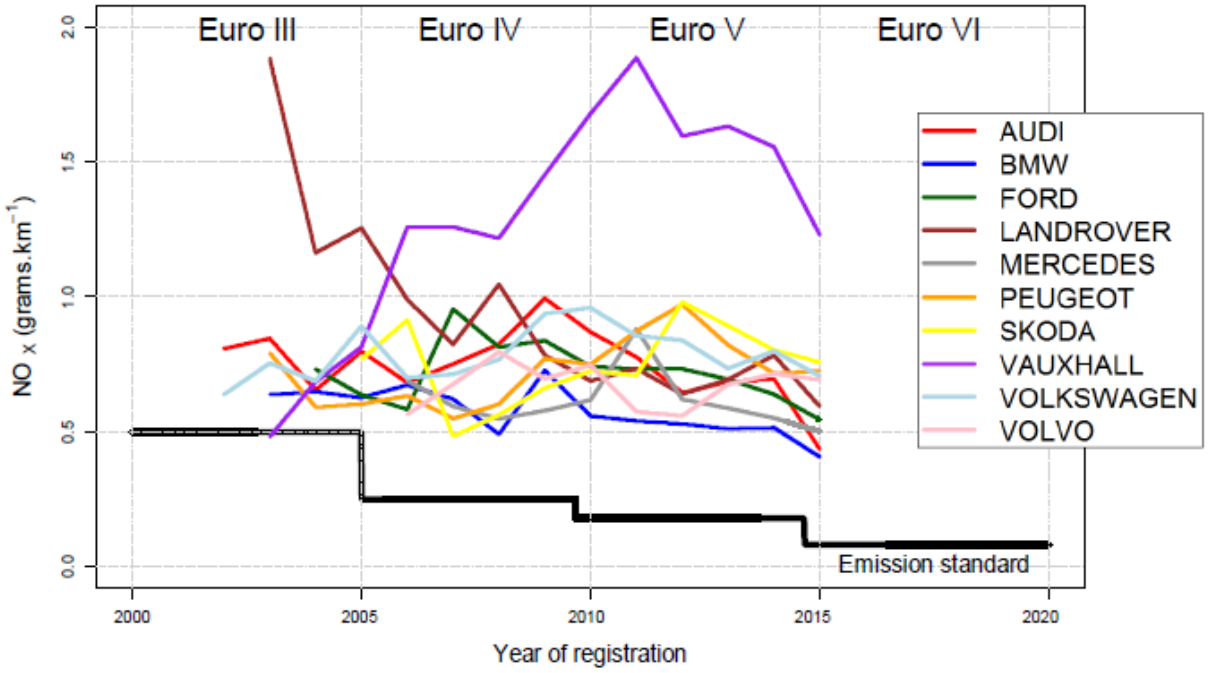
Dr James Tate
Institute for Transport Studies,
University of Leeds, UK
Email: j.e.tate@its.leeds.ac.uk
Twitter: drjamestate

Routes to Clean Air - Air Quality Conference - IAQM
Friday 23rd October 2015

Mesures sobre el trànsit rodat

Manufacturer comparison

Euro VI



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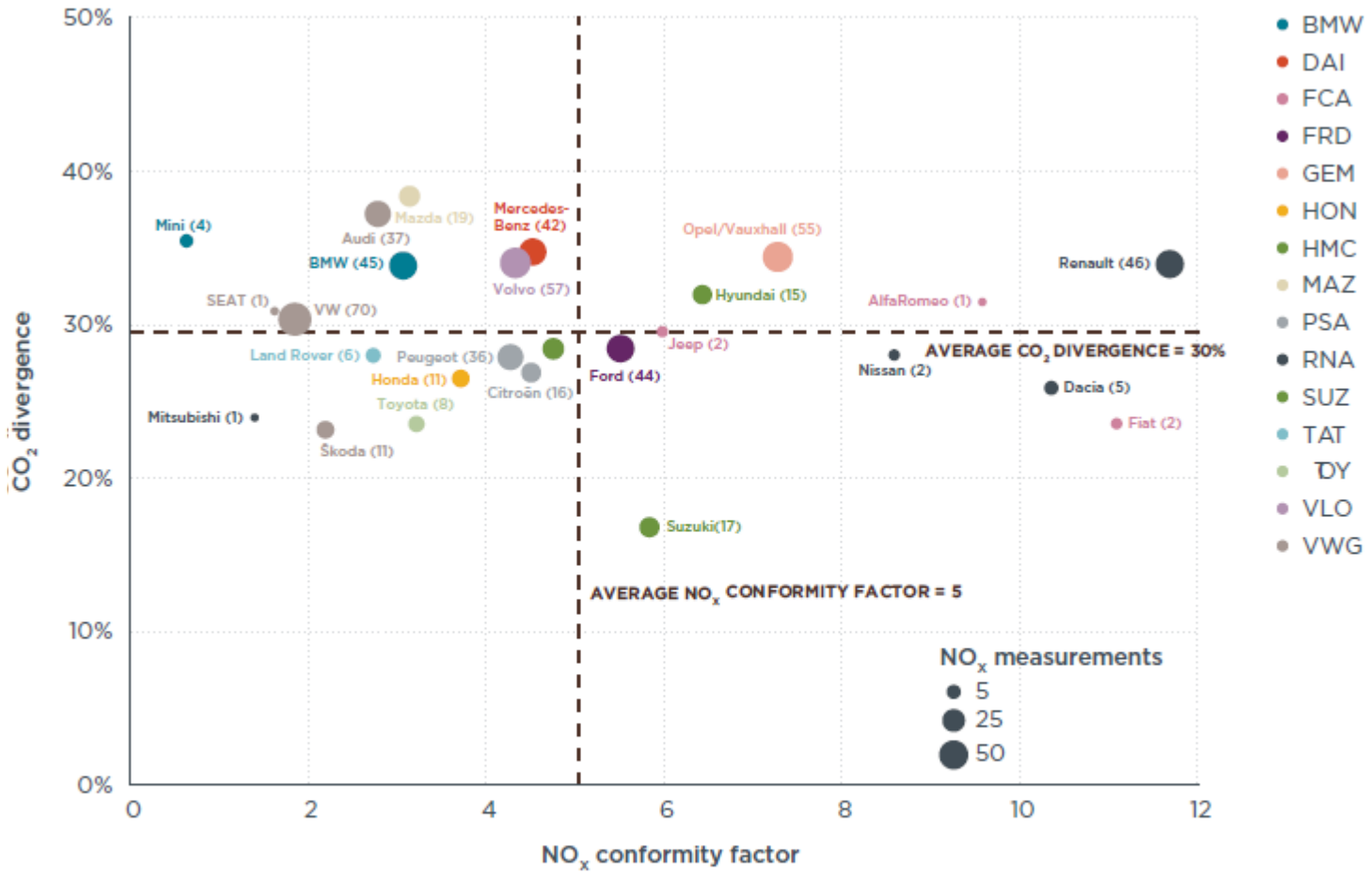
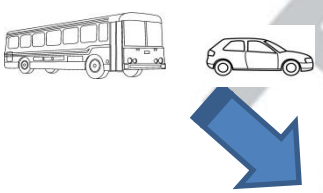


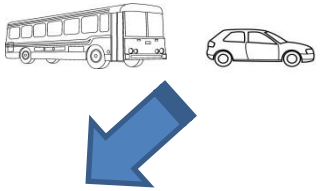
Figure ES-3: Euro 6 diesel passenger car gap between real-world and type-approval CO_2 emission values vs. on-road NO_x emissions conformity factors by manufacturer.[4]

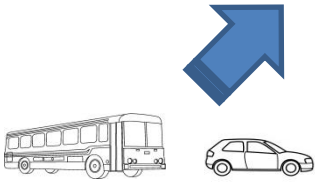
Mesures sobre el trànsit rodat

1. Mesures per reduir vehicles circulants



1.1. Transport públic
1.2. Peatge urbà
1.3. Restriccions pàrquing





Mesures sobre el trànsit rodat

1. Mesures per reduir vehicles circulants

The New York Times

Driving a Car in Manhattan Could Cost $11.52 Under Congestion Plan

By JIM DWYER and WINNIE HU JAN. 18, 2018

698

RELATED COVERAGE

Your Uber Car Creates Congestion. Should You Pay a Fee to Ride? DEC. 26, 2017

For Congestion Pricing Plan, New Support and Steadfast Critics DEC. 29, 2017

Cuomo's Congestion Pricing for New York City Begins to Take Shape JAN. 16, 2018

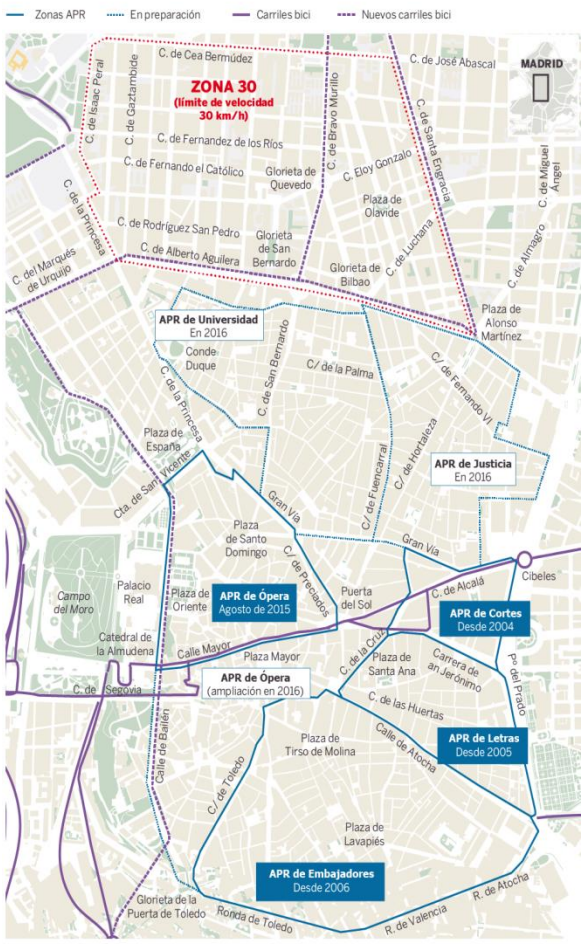
New York's Tilt Toward Congestion Pricing

Mesures sobre el trànsit rodat

AYUNTAMIENTO DE MADRID ›

El Ayuntamiento de Madrid anuncia que restringirá el tráfico en gran parte de Centro en 2018

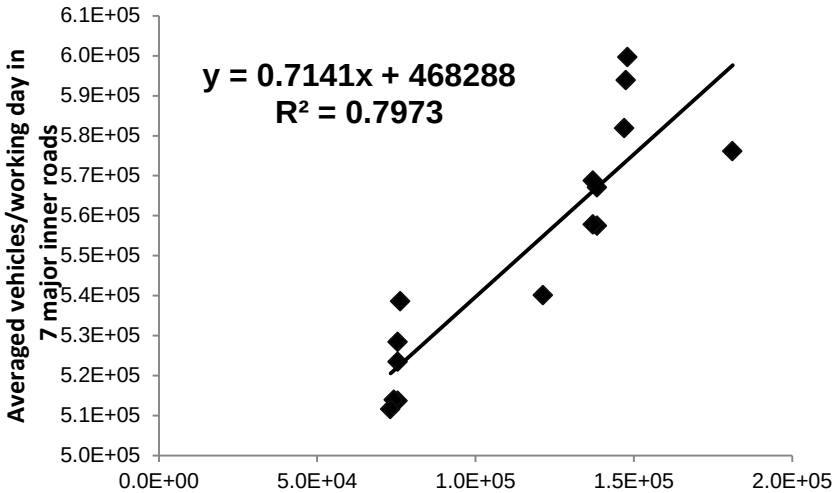
El gran Área de Prioridad Residencial de Centro "podrá ser una o dos" en función de si se parte o no por Gran Vía



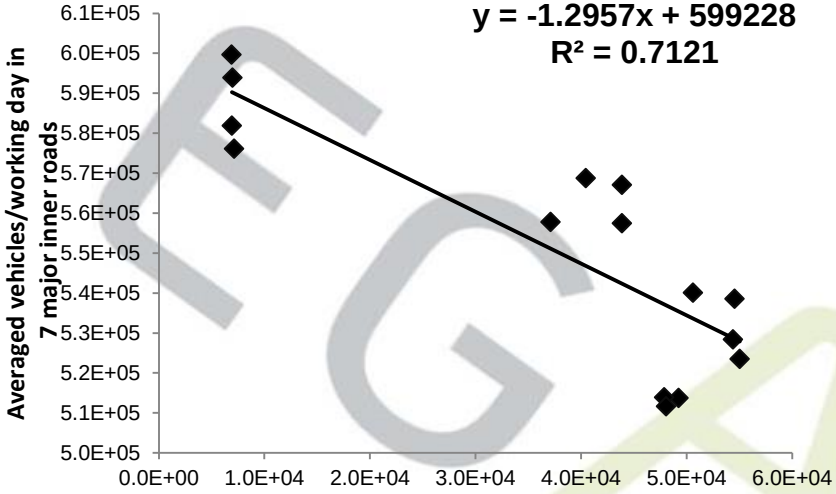
EL PAÍS

LUCA COSTANTINI

Madrid - 6 OCT 2016 - 17:36 CEST



Parking free places in the city of Barcelona



Payment or resident restricted parkings in Barcelona

BARCELONA-2001-2015

Querol et al., 2017. Non technological measures for urban air quality

Mesures sobre el trànsit rodat

2. Mesures per renovar flota i eliminar vehicles més contaminants

ZBE: Positiu per PM (BC)
Ineficient per NO_2

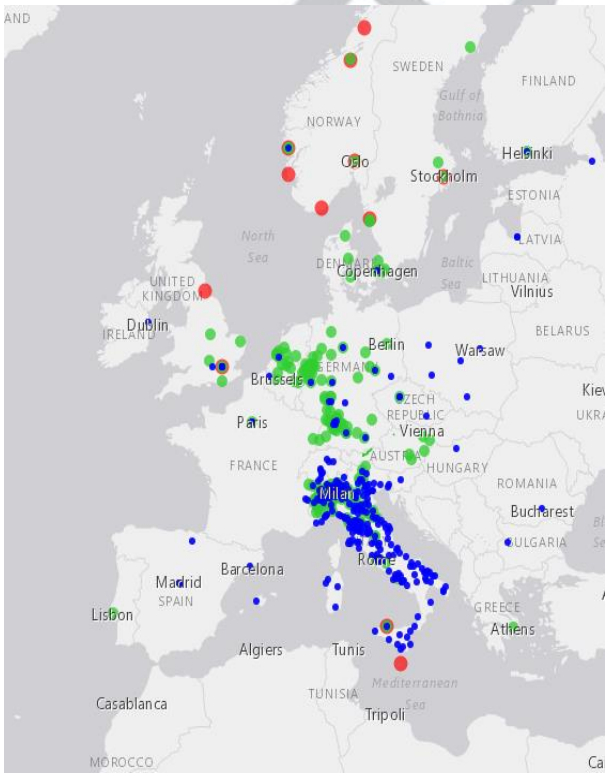
If we reduce vehicles by 30%, the 70% that will access have to be clean!!!!!

+ plug-in mobility

Mesures sobre el trànsit rodat

2. Mesures per renovar flota i eliminar vehicles més contaminants

- LEZs
- Congestion Charge
- Other restrictions



http://es.urbanaccessregulations.eu/

NOW: CLEAN AIR ZONES (CAZS) IN UK

- **Must apply to ALL vehicle types**
- **Strict in application**
- **Also motor pets and motorbikes**
- **Use real world driving criteria**

LOW EMISSION ZONES

15 MEMBER STATES, 280 CITIES:

- DE, NL, UK, NO, SE, DK, CZ, AT, HU, IT

AT (3)
Autopistes Tirol
CZ (1)
Praga
DE (50)
Augsburg, Berlín, Bochum, Bonn, Bottrop, Bremen, Dinslaken, Dortmund, Duisburg, Düsseldorf, Essen, Frankfurt, Friburg, Gelsenkirchen, Halle (Saale), Hannover, Heidelberg, Heilbronn, Herrenberg, Ilsfeld, Karlsruhe, Köln (Colonia), Krefeld, Leipzig, Leonberg, Leonberg, Ludwigsburg, Magdeburg, Mannheim, Markgröningen, Mühlacker, Mühlheim, München, Münster, Neu-Ulm, Neuss, Oberhausen, Osnabrück, Pfinztal, Pforzheim, Pleidelsheim, Pleidelsheim, Recklinghausen, Ratisbona, Reutlingen, Schwäbisch-Gmünd, Stuttgart, Tübingen, Ulm, Wuppertal
DK (5)
Aalborg, Aarhus, Frederiksberg, Copenhague, Odense
GB (3)
Londres, Oxford, Norwich
IT (42)
Roma, Milán, Livorno, Pisa, Módena, Nápoles, Palermo, Parma, Pavía, Pisa, Regggio Emilia, Rimini, Torino, Trento, Varese, Verona, Lodi, Lucca, Montove, Mezzocorona, Mondovi, Nichelino, Novara, Novi Ligure, Orbassano, Perugia, Piacenza, Prato, Ravenna.....
NL (13)
Ámsterdam, Breda, Delft, La Haya, Eindhoven, Leiden, Maastrich, Rijswijk, Rotterdam, Hertogenbosch, Schiedam, Tiburg, Utrech
NO (3)
Oslo, Bergen, Trondheim,
SE (6)
Estocolmo, Gotemburgo, Helsinburg, Lund, Malmo, Molndal
FR
Paris: Testing in 2012

Mesures sobre el trànsit rodat

Very positive effect to abate PM

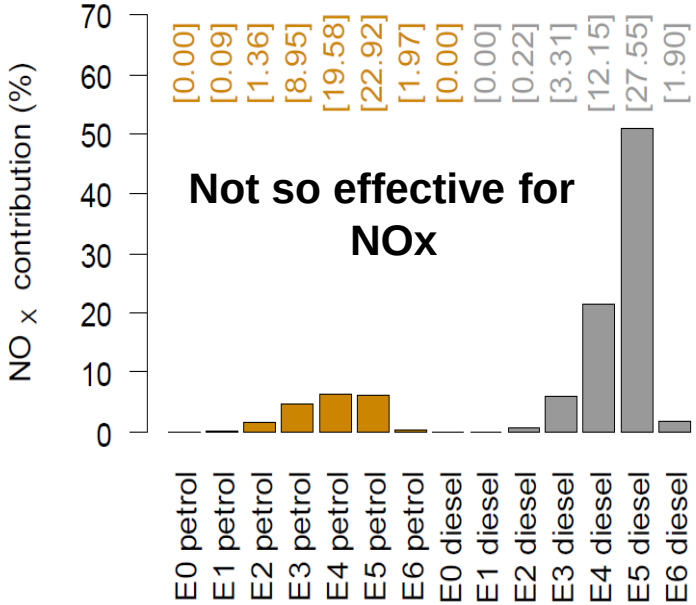
A EURO1 diesel car, can emit PM as 35 EURO5 diesel cars BUT NO EFFECT FOR NO_X

Dr James TATE

Email: j.e.tate@its.leeds.ac.uk

Twitter: drjamestate

-C:



Vehículos M1 y N1 clasificados
EURO 4/IV, 5/V o 6/VI o diésel EURC
Vehículos M2, M3, N2 y N3 cla
gasolina Euro VI/6 o diésel Euro VI/6

os en el Registro de Vehículos como gasolina
5/V.
clasificados en el Registro de Vehículos como
uro IV/4 o V/5.»

Without ecolabel

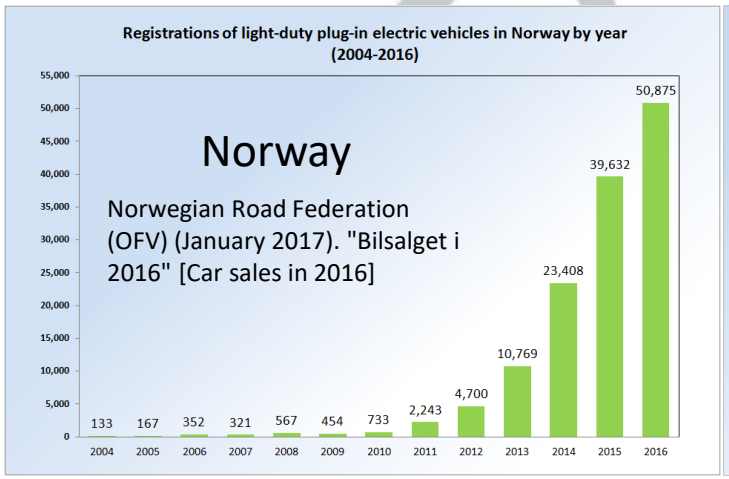
5. Gasolina EURO 0, 1 y 2 y Diesel EURO 0, 1, 2 y 3

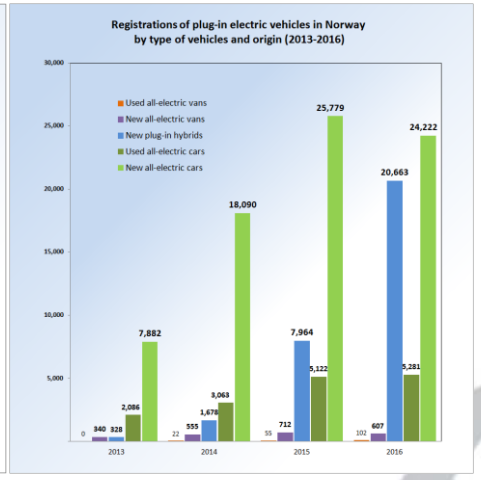
Mesures sobre el trànsit rodat

2. Mesures per renovar flota i eliminar vehicles més contaminants

VEHICLE ELÈCTRIC

19% of market share in 2016





- Long term fiscal incentives from 1990s
- Incentives added sequentially until the market responded
- The price difference between battery EV and petrol car can be €1,000
- Exempt from
  - vehicle registration tax
  - road tolls
  - VAT (normally 25%)
- Bus lane access
- BEVs -reduced annual tax
- Reduced rates on the main coastal ferries

Norway 5.8%; Netherlands 5.4%; EU-28 0.4% (2013)

2016 with 5% of all passenger cars on Norwegian roads being a plug-in

- **Començar per vehicles comercials amb molts km/day en ciutats**
- **Motos**

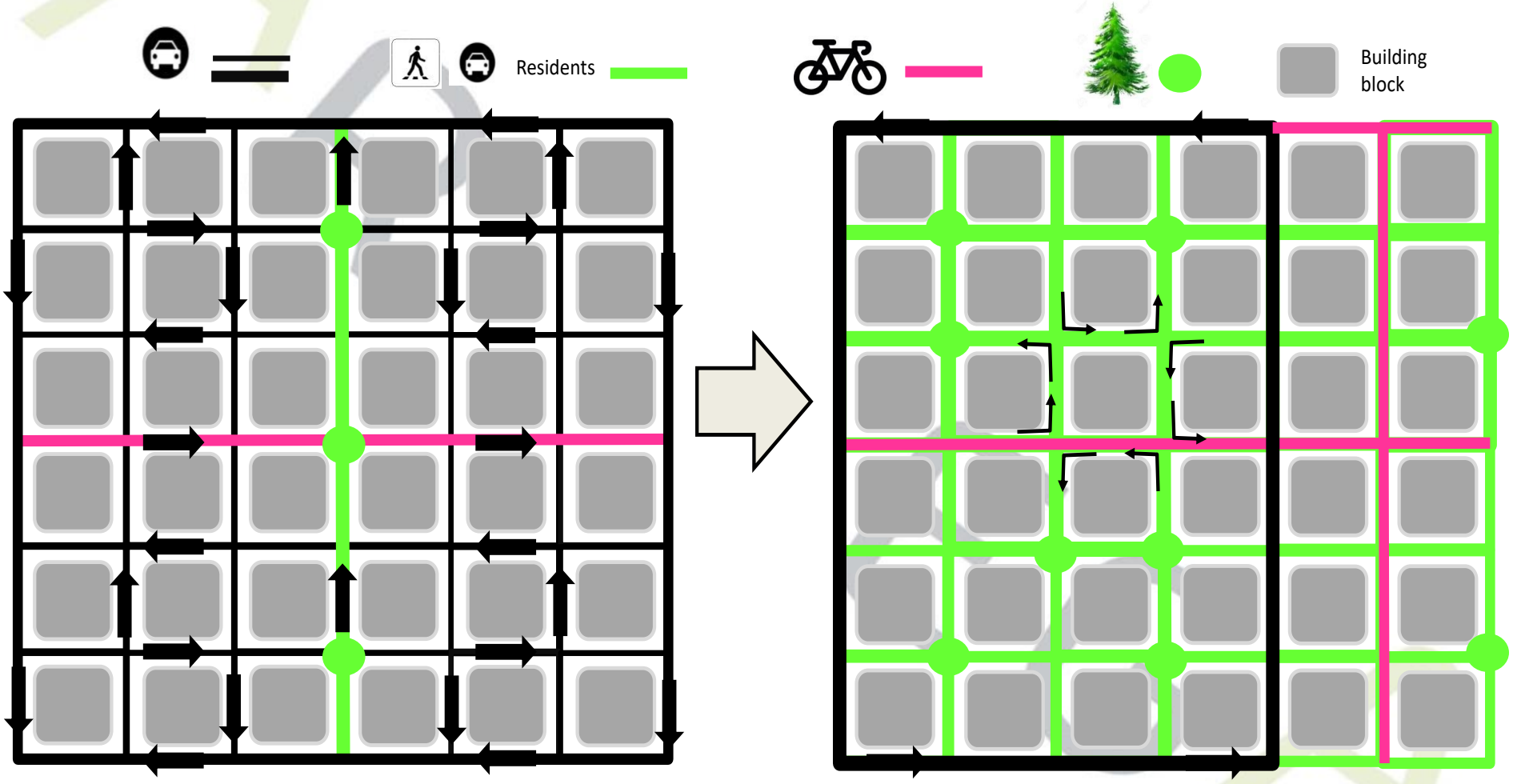
Mesures sobre el trànsit rodat

3. Distribució urbana de mercaderies

- Electrificació i hibridació preferent , 1 vehicle DUM = 12 cotxes privats a causa de kmtratge
- Restriccions de 7 a 11 hores (meteo desfavorable i densitat de trànsit)
- Logística intel·ligent (nocturna, micro-plataformes logístiques...)
- Normes estrictes i compliment de normativa volum mínim disponible per a l'emmagatzematge de mercaderies
- Evitar la circulació de taxis vuits

Mesures sobre el trànsit rodat

4. Re-disseny urbà: verd, peatonal, bicis,.....

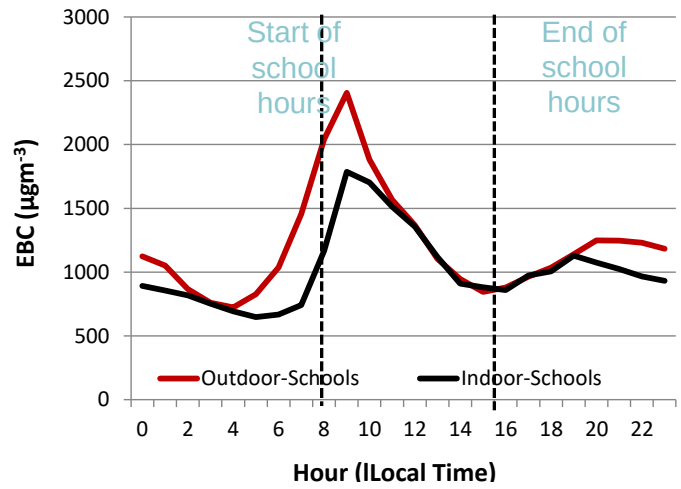


Super-Illes (Barcelona)

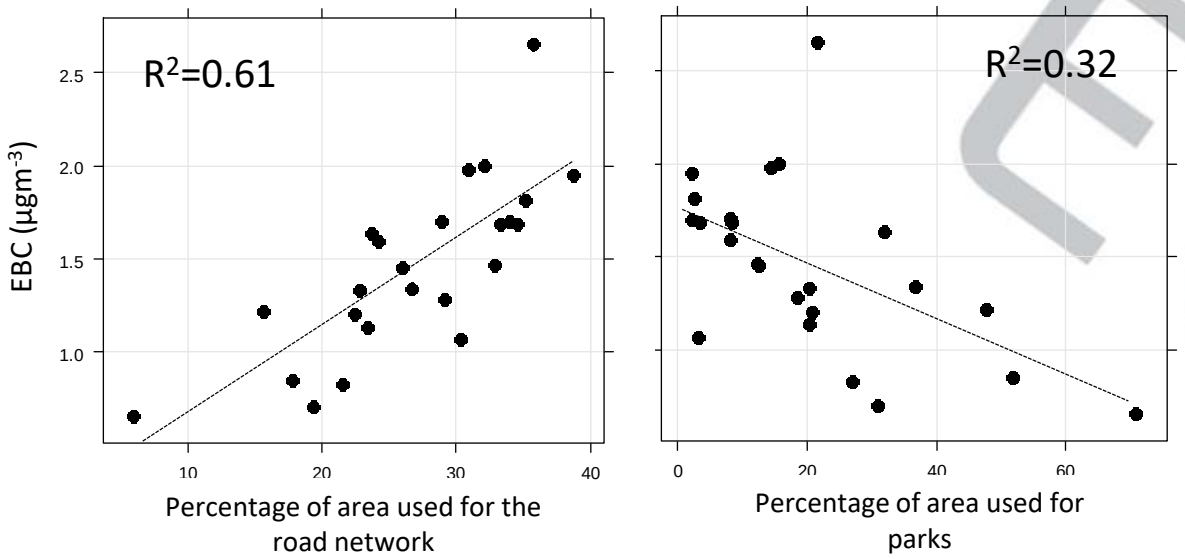
Mesures sobre el trànsit rodat

In & outdoor

Parallelism between mean indoor and outdoor daily cycles. Peaks of exposure inside the classrooms determined by outdoor concentrations



A main contribution of road traffic emissions on indoor and outdoor Elemental Black Carbon (EBC) levels was evidenced



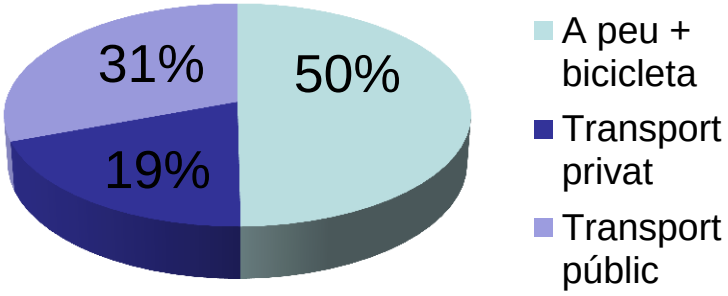
High correlation between average EBC levels at different districts of the city of Barcelona and the percentage of surface area used for the road network

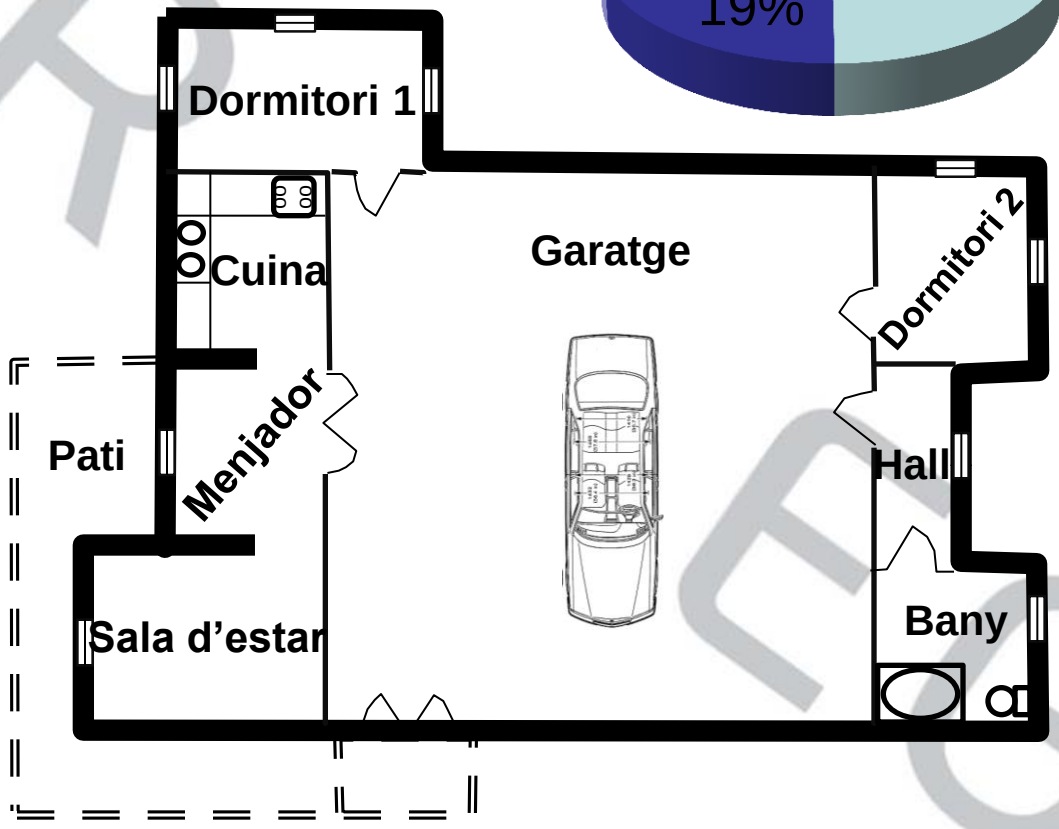
BREATHE

Reche et al., 2015. Real-time indoor and outdoor measurements of black carbon at primary schools. *Atmos. Environ*. *Under review*.

Agraïments: AIRUSE-LIFE, C.E. + AXA Foundation

2.575 Ha superfície residencial a Barcelona (Ajuntament de Barcelona)
2.317 Ha xarxa viaria





¡ Gràcies per la seva atenció!

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Air quality in Europe

EU & WHO standards

	2008/50/EC RD 102/2011	WHO (2006) guidelines	
Hourly	350 µg/m³ SO_2	--	24 times per year
Daily	125 µg/m³ SO_2	20 µg/m³ SO_2	3 times per year
Hourly	200 µg/m³ NO_2	EC-WHO coincide	18 times per year
Annual	40 µg/m³ NO_2	EC-WHO coincide	not exceeding
Annual	5 µg/m³ C_6H_6	EC-WHO coincide	not exceeding
Mean 8-h max. in a day	10 mg/m³ CO	EC-WHO coincide	not exceeding
Annual	500 ng/m³ Pb	EC-WHO coincide	not exceeding
Annual	40 µg/m³ PM10	20 µg/m³ PM10	not exceeding
Annual	25 µg/m³ PM2.5	10 µg/m³ PM2.5	not exceeding
Max 8 h means of a day mean for 3 years	120 µg/m³ O_3	100 µg/m³ O_3	not exceeding 25 day/year
BaP annual	1 ng/m³ BaP	0.12 ng/m³ BaP	not exceeding

Critical pollutants

The problem of NO_2

Why so high NO_2?

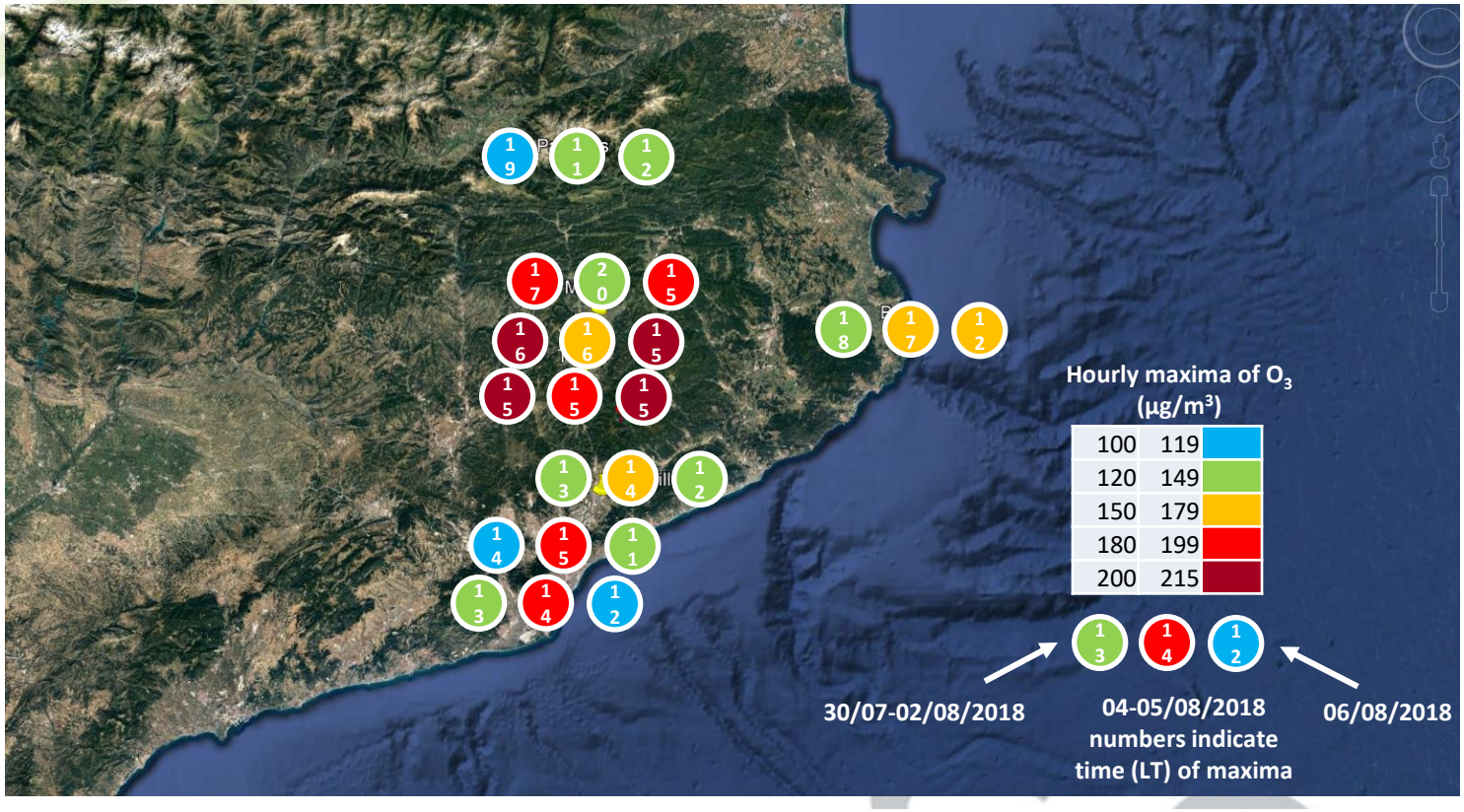
Ámsterdam

Madrid

Barcelona

Napoli

The problem of ozone



Exceedances of the h-information threshold 180 µg/m³ O_3/air quality site