



PSA Peugeot Citroën technologies for an even more environmentally friendly Diesel engine

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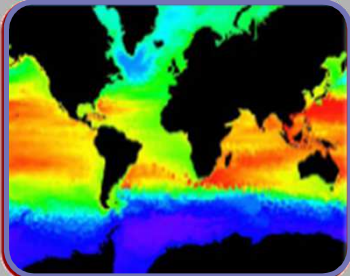
ATMOS'FAIR, September 2013

Today's challenges ... will become opportunities for tomorrow



Urbanisation

2015: 350 million people will live in megacities
➔ **infrastructures and mobility challenges**



Climatic
Change and air
quality

➔ **Environmental challenge**



Evolution of
customer's
needs

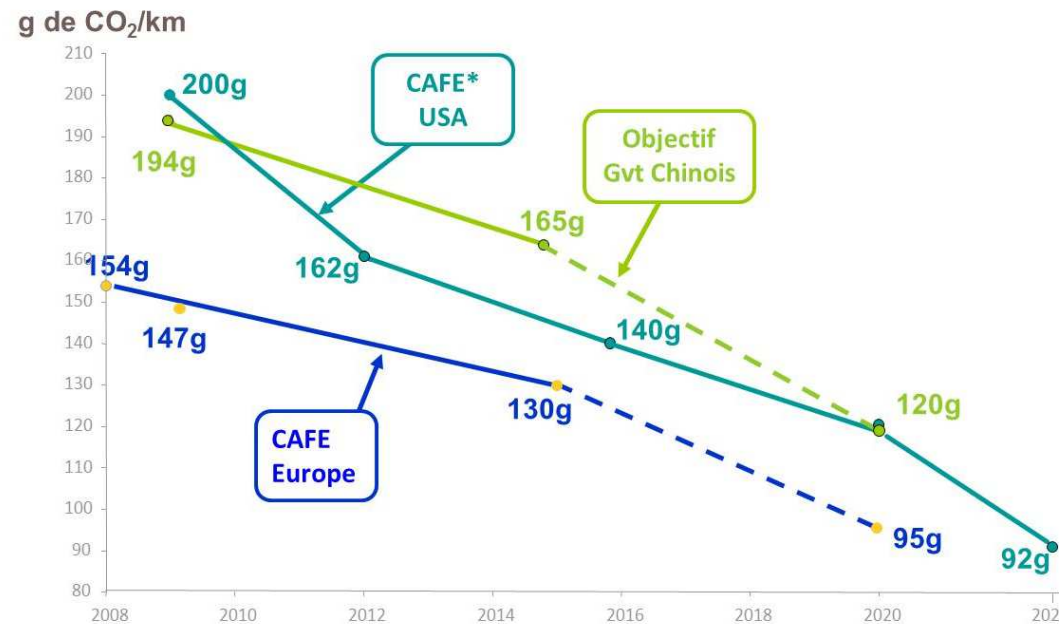
➔ **Technical and Industrial challenges**

Automobile and Environment : two priorities



■ Reduction of green house gas emissions (global warming)

- For the Automotive industry, the challenge is to decrease vehicle CO₂ emissions by improving fuel economy

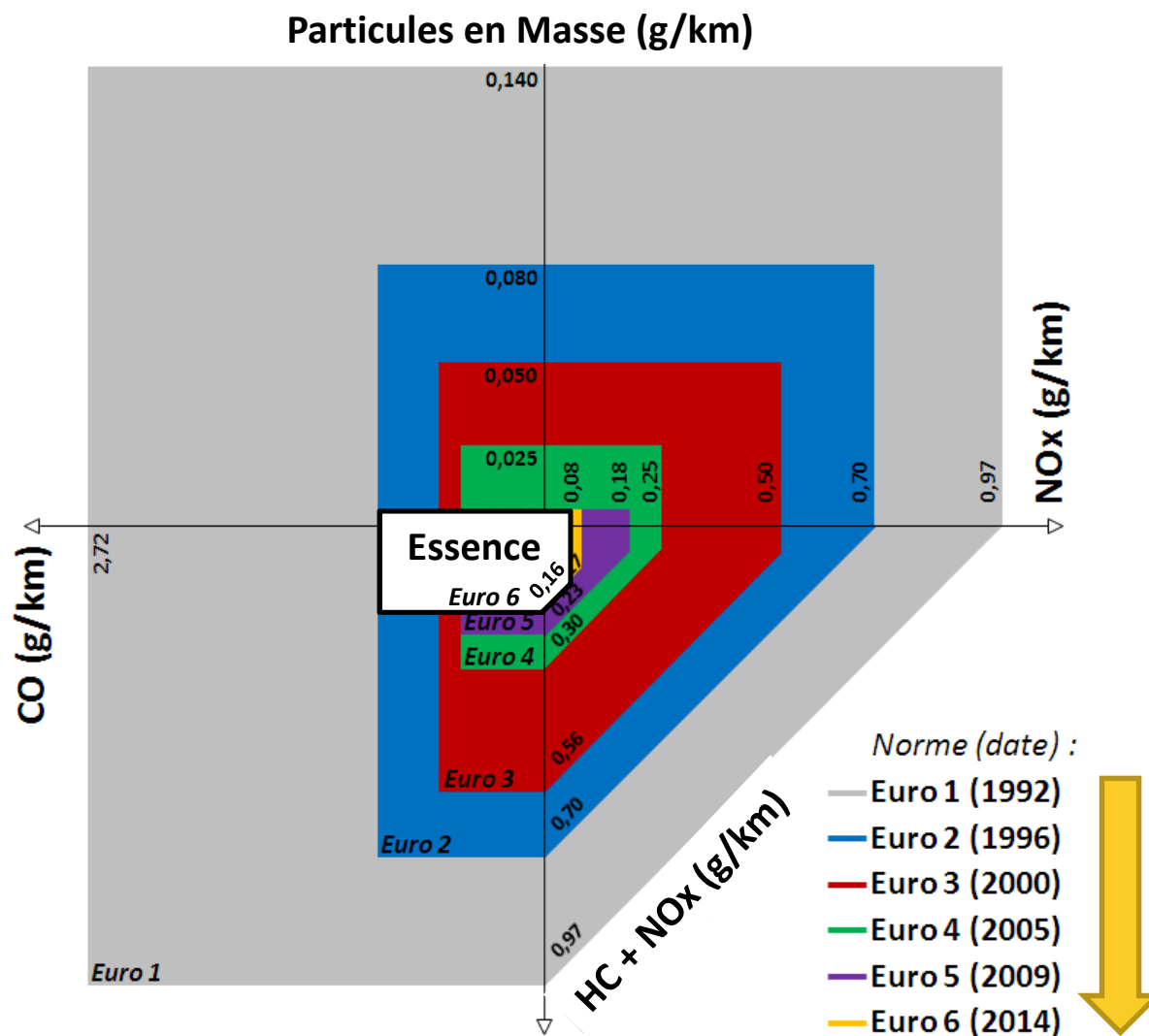


* Corporate Average Fuel Economy : consommation/émission de CO₂ moyenne pondérée des véhicules neufs vendus dans l'année

■ Reduction of pollutants (air quality)

- For the Automotive Industry, the challenge is to limit emissions resulting from the combustion process

Regulated emissions : hardening of Diesel thresholds that now meet gasoline ones



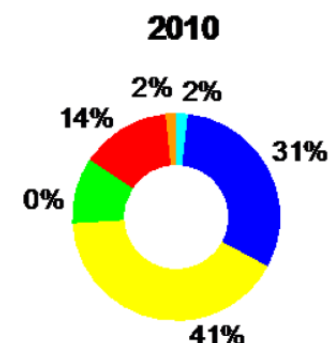
Source CCFA, véhicules particuliers

Major sources of the two pollutants associated to Diesel: fine particles (PM_{2,5}) and of nitrogen oxides (NOx) in France in 2010



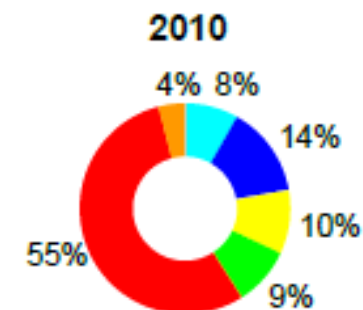
Particles

- 14% of fine particles (PM_{2,5}) are emitted by the road transport sector, far behind the residential/tertiary sector (41%) or by the industrial sector (31%) in 2010
- 27% of PM_{2,5} are emitted by the road transport sector in Ile-de-France



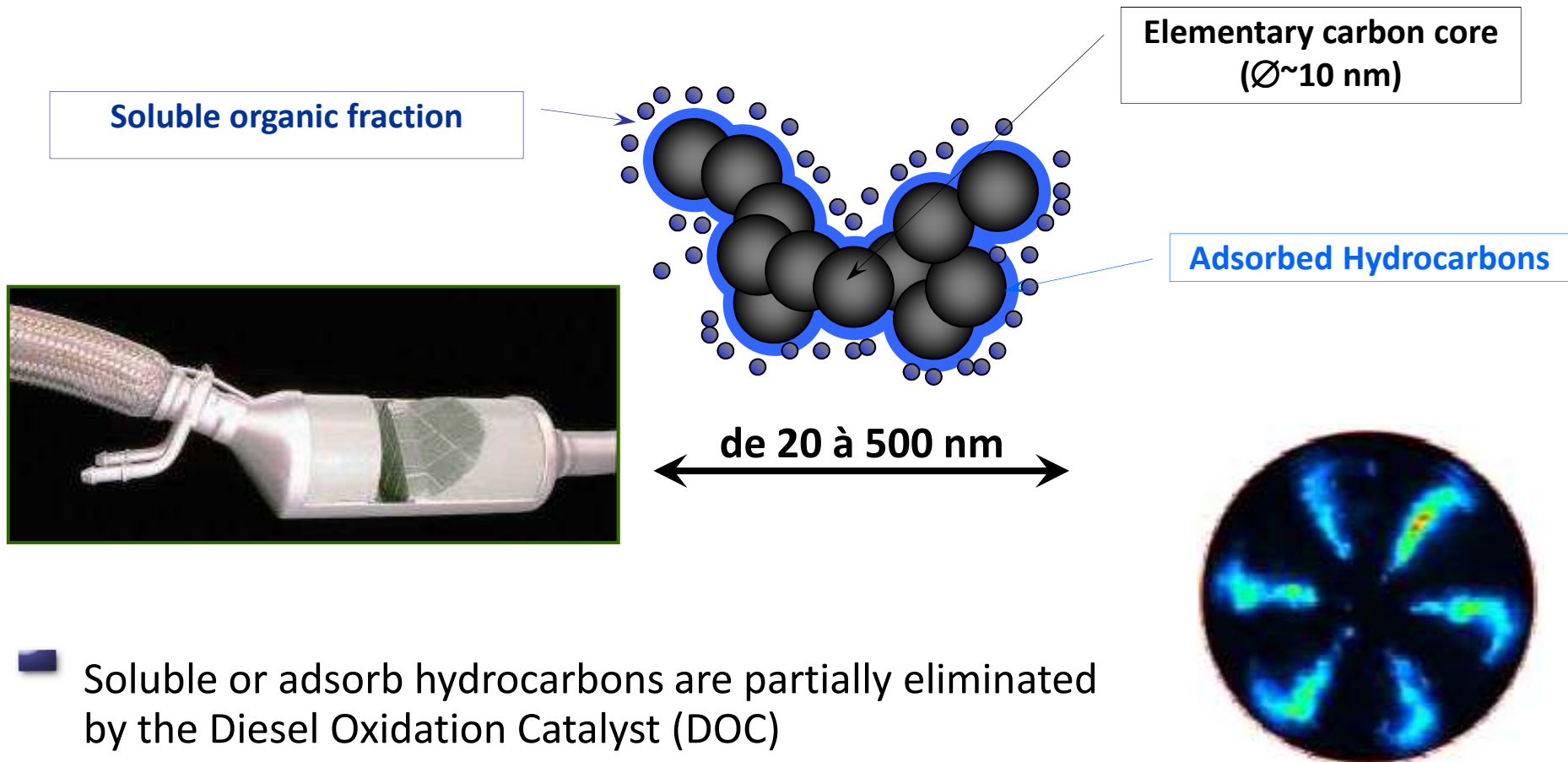
Nitrogen oxides, NOx

- 55% of NOx are emitted by the road transport sector in 2010
 - Trucks represent 23% of the total
 - Passenger cars represent 17% of the total



Source CITEPA, Inventaire des émissions de polluants atmosphériques et de gaz à effet de serre en France, séries sectorielles et analyses étendues, Format Secten, Avril et Juillet 2012.

Nature of Diesel particles and role of the different bricks of the post treatment system

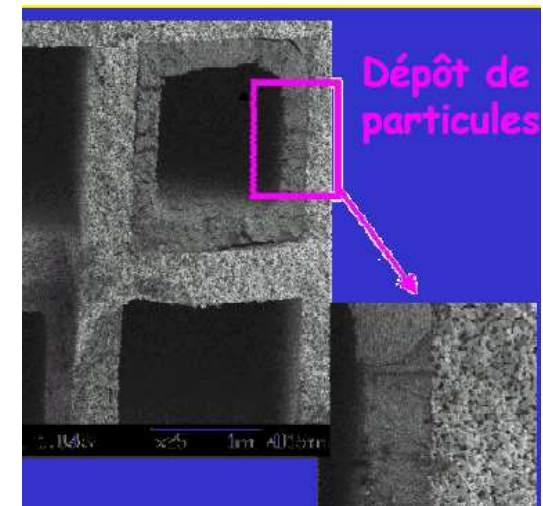
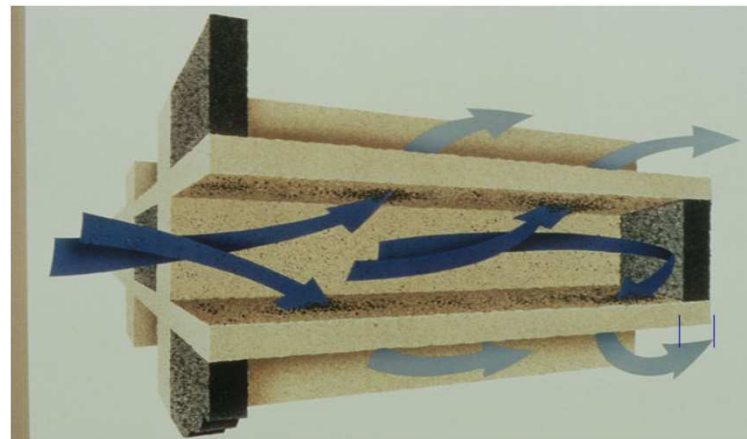
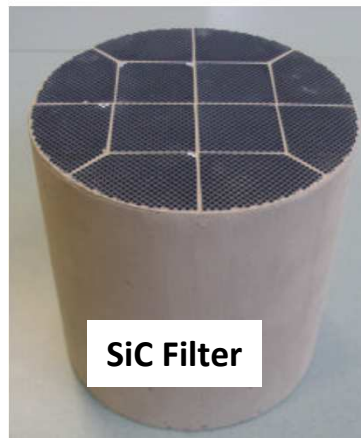


- Soluble or adsorb hydrocarbons are partially eliminated by the Diesel Oxidation Catalyst (DOC)
- Dry soot are collected and eliminated by the Diesel Particulate Filter

PSA Peugeot Citroën's road map to eliminate particulate matter



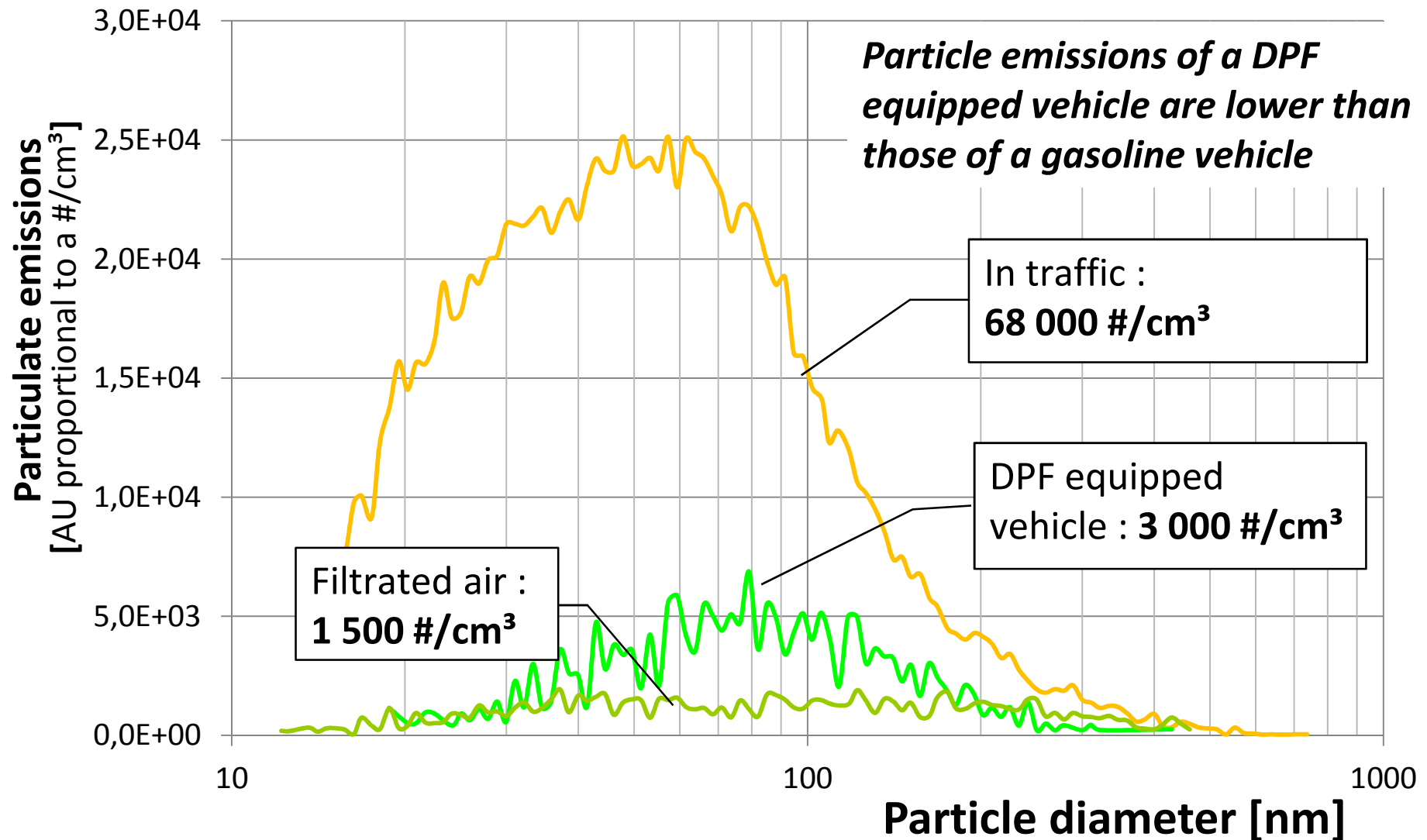
- **1996** : the **oxidation catalyst (DOC)**, to reduce HC, CO and particles
- **1998** : the **HDi engine** (30% reduction of particles in mass)
- **2000** : the **Diesel Particulate Filter (DPF)** launched in world premiere on the Peugeot 607, generalized to all vehicle January 1st 2011
- **DPF : the ultimate solution** to eliminate **ALL particles** (with an efficiency higher than 99.9% in number whatever their size) **in ALL driving conditions**



Exhaust gases are cleaner in terms of particle than the air entering the engine!



— Urban traffic — DPF equipped Diesel AP — Clean filtrated air



Common preconception

DPF equipped vehicles decrease particulate pollution in urban area!

Life situation	Typical particulate levels in air (number per cm ³)
Clean air (mountain ...)	< 1500
DPF equipped Diesel exhaust gas, before dilution in air	< à 3500
Air in a clean room	< à 4000
Air in a urban area	de 10 000 à 20 000
Air close to a heavy traffic road	de 20 000 à 40 000
Cigarette smoke	> 50 000
Air in heavy traffic	Jusqu'à 60 000
Air inside the vehicle, in heavy traffic	Jusqu'à 90 000
Industrial dirty "site"	de 100 000 à 1 000 000
Non DPF equipped Diesel	de 3 000 000 à 4 000 000

Source : données internes

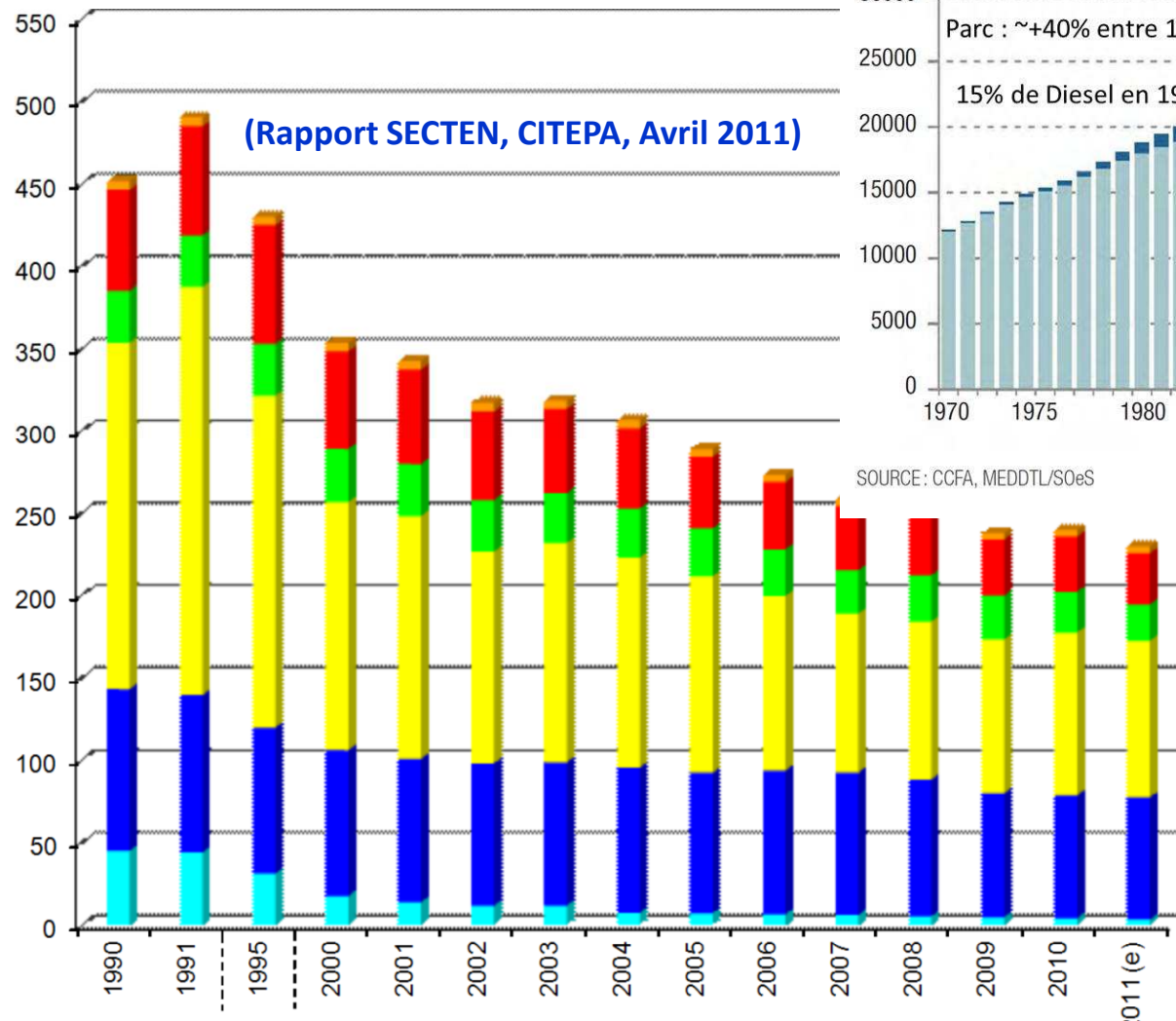
Source : AIRPARIF

Source : <http://www.aqs.com/docs/resource-library/ultrafine-particles-white-paper.pdf>

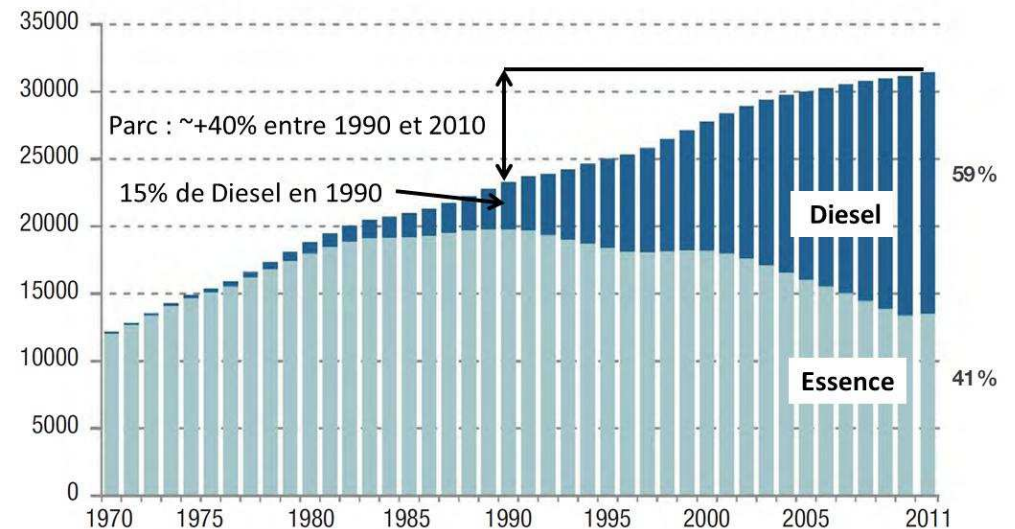
Source : <http://www.aerasense.com/index.php?pageID=3>

In 20 years, the automotive fleet has increased by 40%,
while fine particles ($PM_{2,5}$) were reduced by 50%

Major atmospheric Particulate matter ($PM_{2,5}$) emission sources in France (kT)



31,4 millions de voitures en circulation en 2011, dont 59% de diesel



SOURCE : CCFA, MEDDTL/SOeS

Industrie manufacturière

Transport routier

Résidentiel/tertiaire

Autres transports

Transformation énergie

Agriculture/sylviculture

PSA Peugeot Citroën strategy to reduce nitrogen oxides (NOx)



- **Since Euro1 (1992)**, nitrogen oxides (**NOx**) linked to road transportation were **divided by two** thanks to raw emission reductions :
 - **HDi engine** (high pressure common rail injection)
 - **Combustion optimization** (combustion chamber, Turbocharger, exhaust gas recirculation (EGR)...)

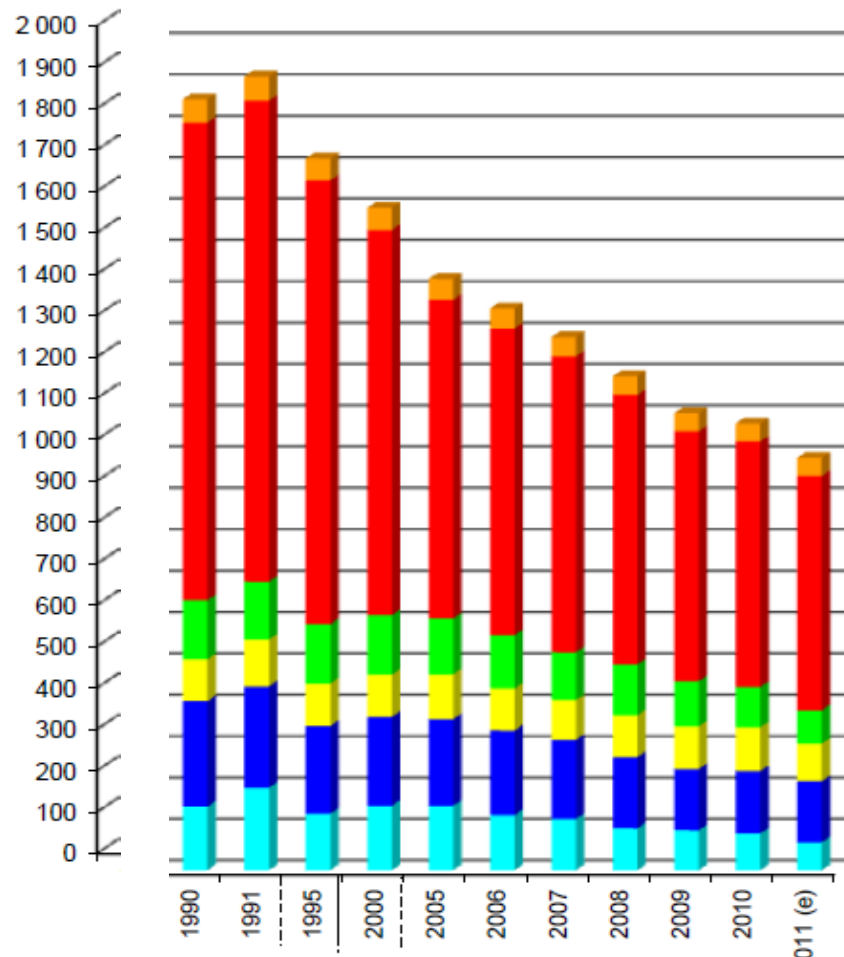
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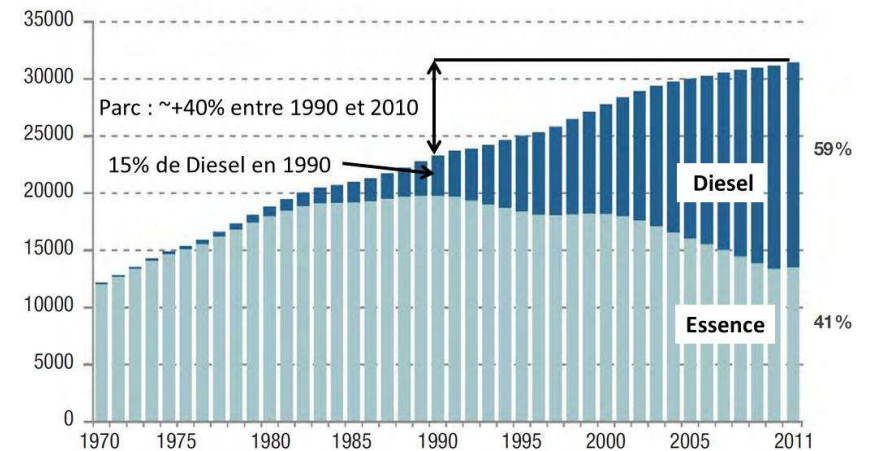


NOx

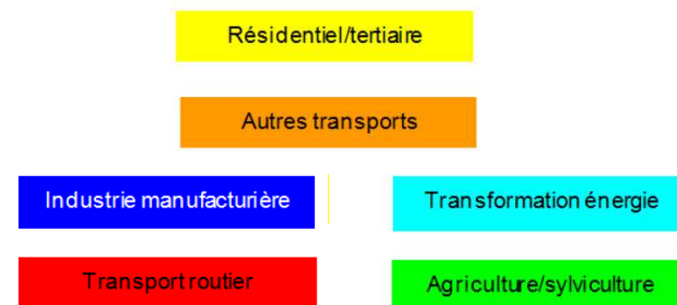
Emissions atmosphériques par secteur en France métropolitaine
en kt



31,4 millions de voitures en circulation en 2011, dont 59% de diesel



SOURCE : CCFA, MEDDTL/SoeS



How to further reduce NOx emissions (56% more) to reach Euro6 limits (80 mg/km)?



(1) Continue to **reduce NOx raw emissions**

- ➔ Strategy limited to light vehicles, at the expense of fuel consumption and CO₂ emissions

(2) Use of a **NOx sequential elimination system, the LNT** (Lean Nox Trap)

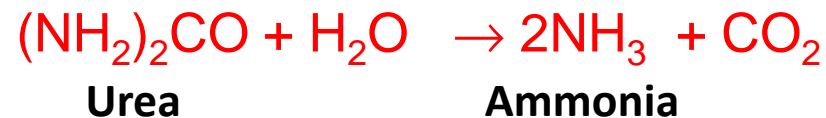
- ➔ Very intrusive system, that leads also to a fuel overconsumption

(3) Use of a **NOx continuous elimination system, the SCR** (selective catalytic reduction)

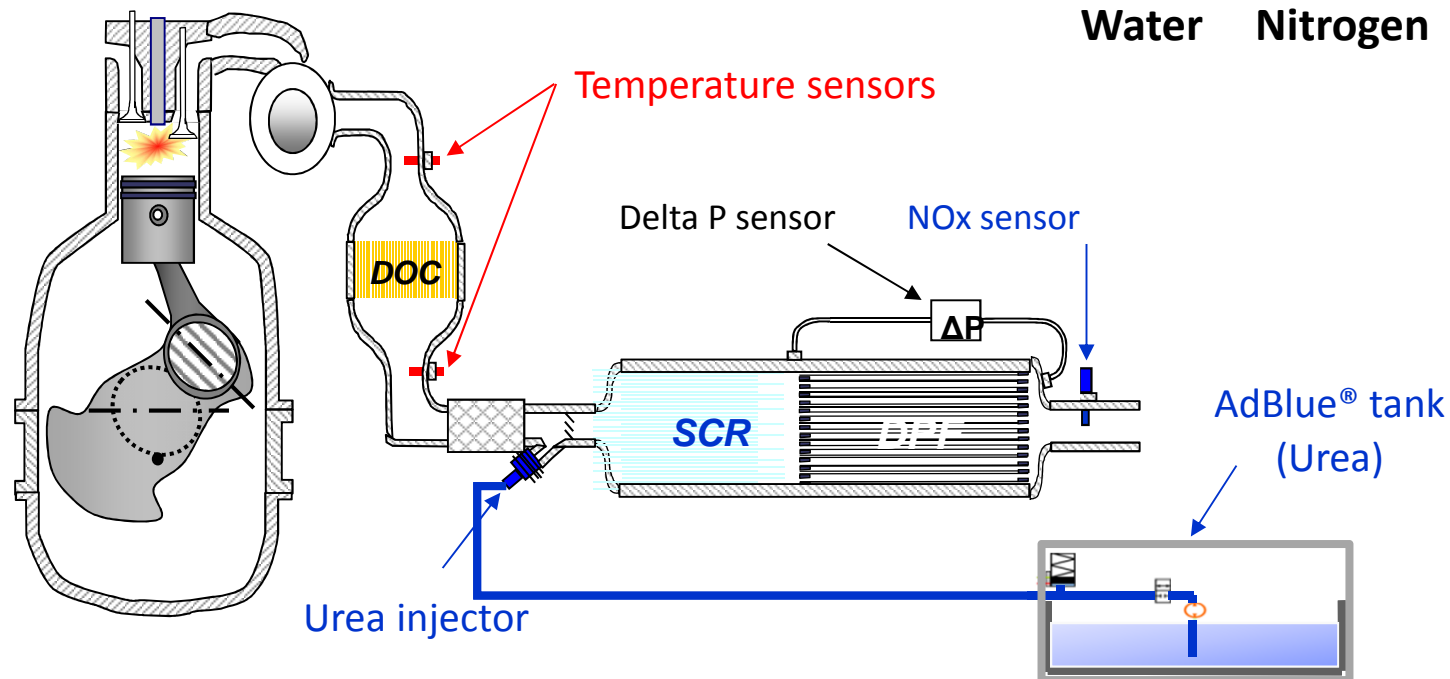
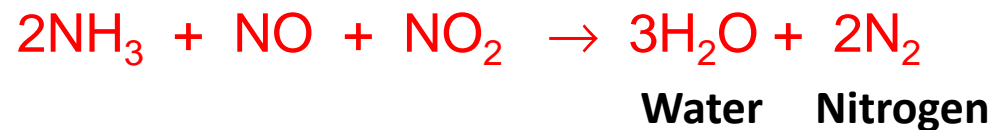
- ➔ The only system combining high NOx reduction with a better fuel efficiency!
- ➔ Technical solution suitable for all vehicles, including high inertia ones

Selective Catalytic Reduction (SCR): the most effective system for eliminating NOx while improving fuel efficiency

- ❶ Adblue® (urea) converted into ammonia (NH₃) in the exhaust line



- ❷ NOx reacts with ammonia (NH₃) to produce nitrogen and water



BLUE HDi : PSA Peugeot Citroën solution to further reduce the automobile impact on environment

- **Blue HDi and global warming** : up to 4% CO₂ reduction compared to Euro5 engines
- **Blue HDi and air quality** : the most efficient solution to treat NOx (up to 90% of efficiency) and particulate matter (more than 99,9% efficiency in number)



PSA Peugeot Citroën will introduce Blue HDi technology starting end 2013 on all its new Diesel engines to offer to its customers more and more environmentally friendly vehicles

Why AdBlue® needs will increase in the future?



■ To meet Euro6c RDE constraints (2017), there is still a balance between

- a “low CO₂” oriented calibration, that will induce a higher AdBlue® consumption to treat the resulting NOx
- a “low Nox” oriented calibration, that will induce a higher fuel consumption and consequently higher CO₂ emissions

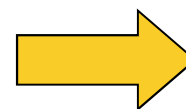
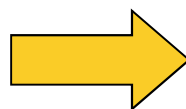
➔ **The balance will be adjusted to reach the highest benefit for the customer, taking into account Air Quality and Global warming constraints**

● The real “cost” for the customer will include:

- **the retailing price of AdBlue®, with a target cost for the passenger car owner close to the actual one for Trucks (0,4€/l in France)**
- **the personal investment for the customer to refill the AdBlue® tank, which includes easy finding and handling!**

Requirements for a dense AdBlue® infrastructure

Our view of 2013 - 2020 evolution and onwards, to facilitate the refilling




First step (2013-2015):
Inter-service and refill by
bottles

Intermediate step (2015-
2017): dollies

Final step (>2017):
Distribution pumps

An equilibrated Powertrain strategy

Gasoline strategy : looking for more efficient engines

-  To develop more fuel efficient engines in order to decrease CO₂ emissions, while maintaining the low emission level of pollutants
 - ⇒ EP Family : 4cyl engines of 1.6l , developed in cooperation with BMW
 - ⇒ EB Family : 3cyl engines of 1 et 1,2 l. The atmospheric version is already launched on the Peugeot 208 et Citroën C3, the turbocharged version will be launched in 2013

Diesel strategy : towards an even more environmentally friendly engine

-  To continue the tremendous improvement in terms of emissions, focusing on NO_x, while maintaining the advantage of Diesel in terms of fuel economy (20%) and attributes (torque) compared to gasoline.

Hybrid strategy : to develop optimized solutions, adapted to Diesel or gasoline engines, to further improve fuel economy (Hybrid 4 Diesel, Hybrid Air...).