

Current situation and perspectives on vehicles real-world emissions.

Yoann Bernard
ICCT Europe

Bruxelles Environnement - Colloque de présentation de
la fin de la consultation sur la sortie des moteurs
thermiques

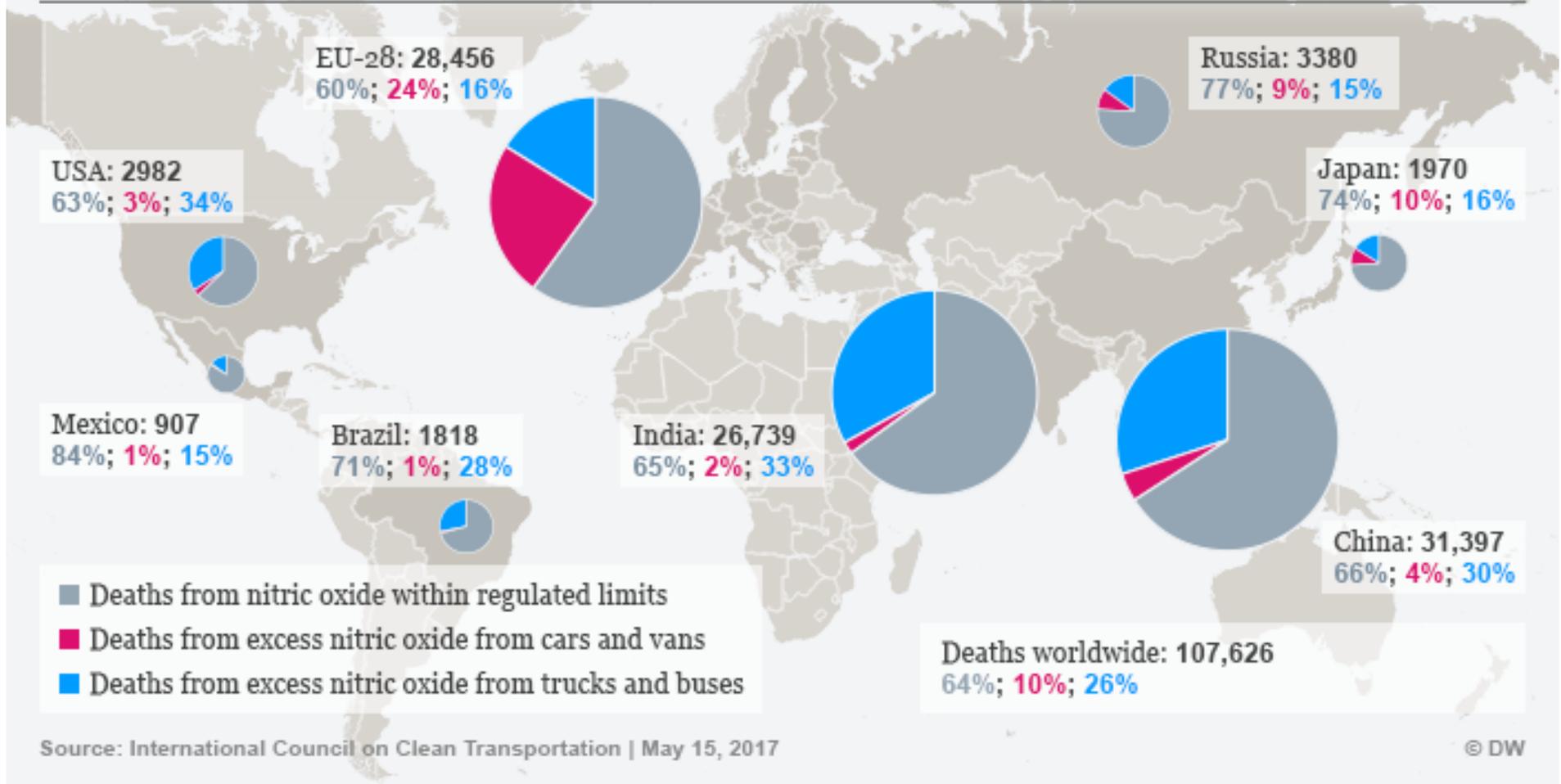
April 23th 2019



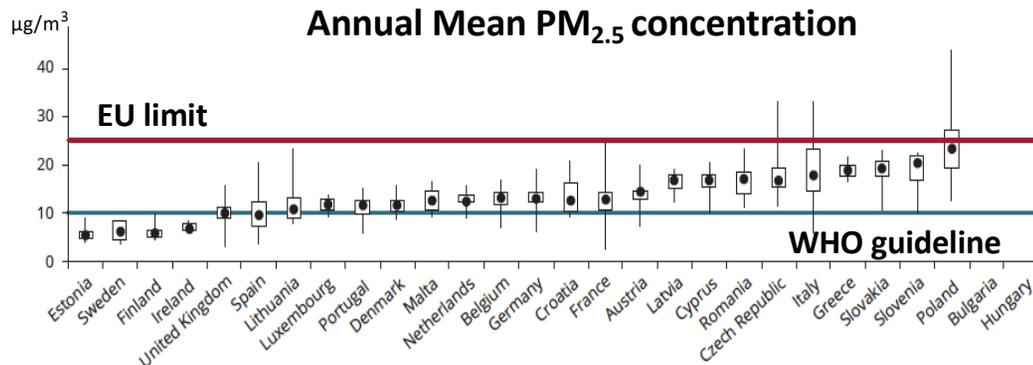
The problem: air quality in cities related
to excess of emissions

In Europe, more than 11,000 people die early because of excess diesel NO_x emissions, every year

Deaths caused by nitric oxide from diesel engines worldwide in 2015

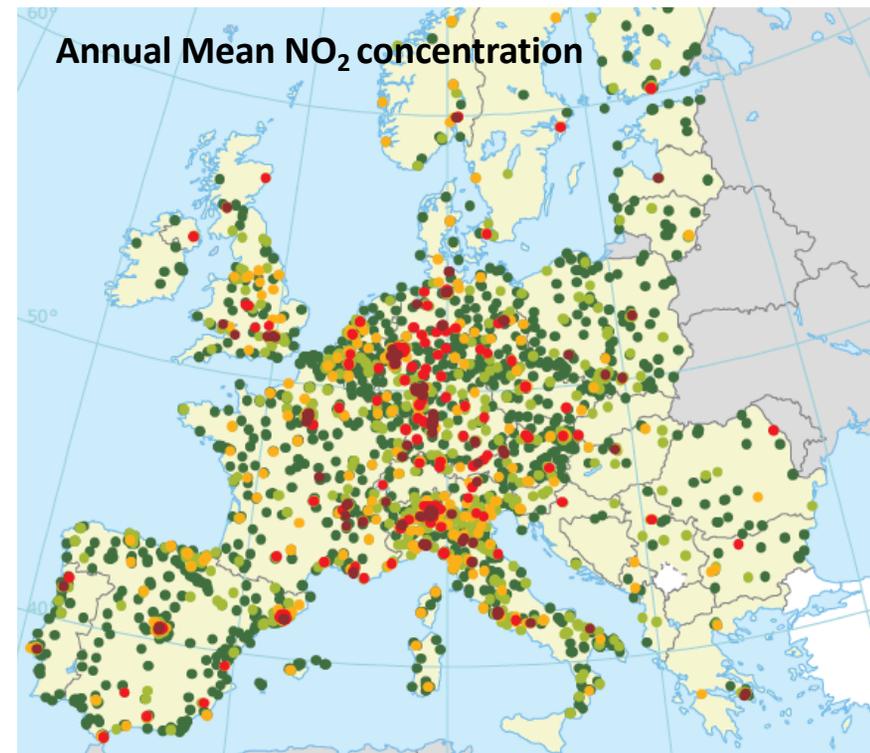


EEA report: “Air pollution is the single largest environmental health risk in Europe...”



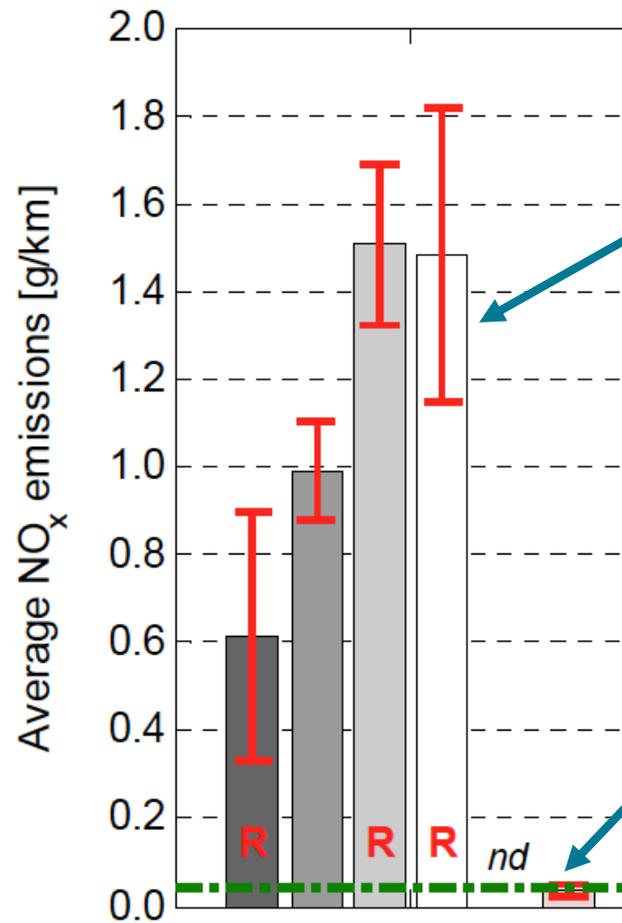
- The WHO guideline for PM_{2.5} was **exceeded at 75 %** of the stations

- **22 of the EU-28** countries recorded NO₂-concentrations above the annual limit value
- **Almost all stations** with values above the annual limit value were **urban**



Current situation on vehicles real-world emissions

A comparison of laboratory vs. on-road test results for 3 diesel cars in the US triggered “Dieselgate”



On-road test

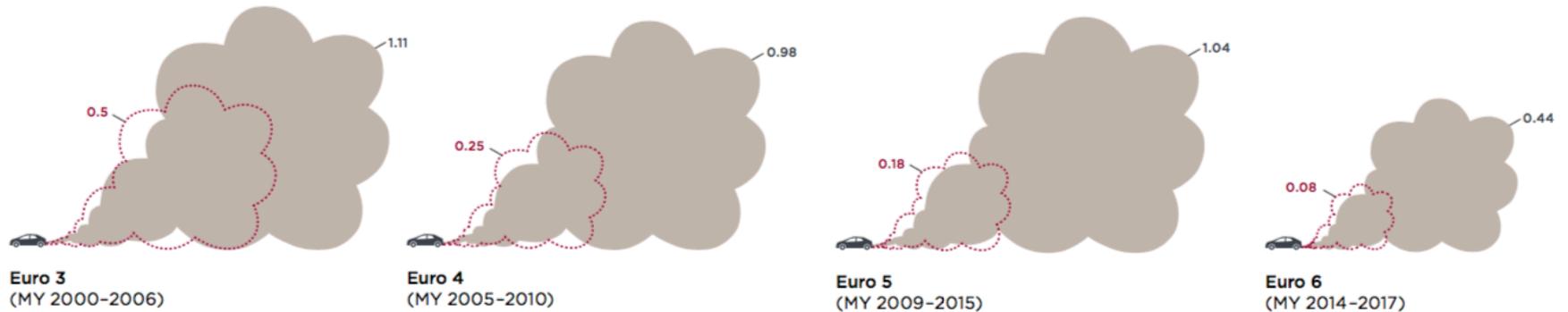


Laboratory test



The importance of enforcement: NO_x emissions from diesel cars in Europe have not decreased as expected

Diesel cars: Nitrogen oxide (NO_x) emissions (in g/km)



Gasoline cars: Nitrogen oxide (NO_x) emissions (in g/km)

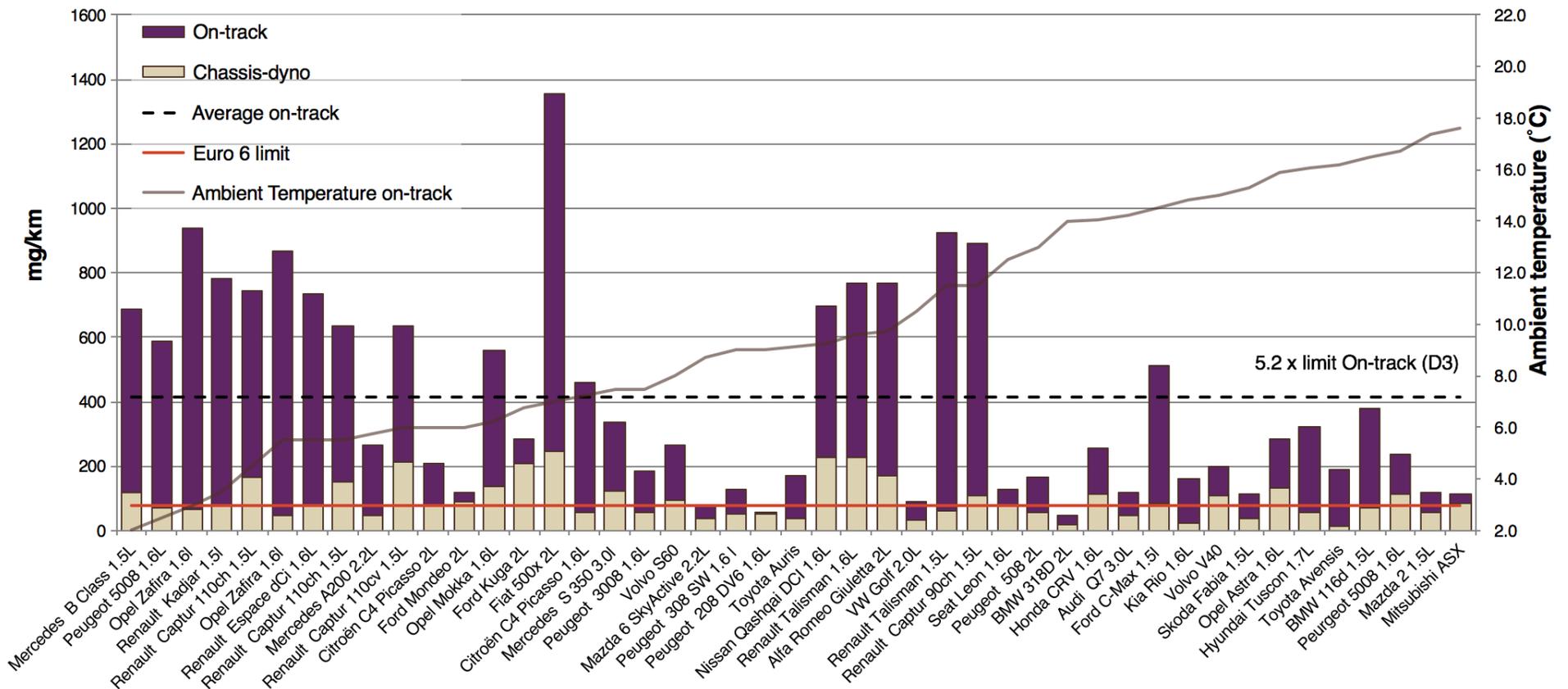


■ On-road measured value, measurements taken between 2011 and 2017
 Euro emission limit

French on-track testings demonstrates that the type-approval cycle itself is not the only cause of discrepancy

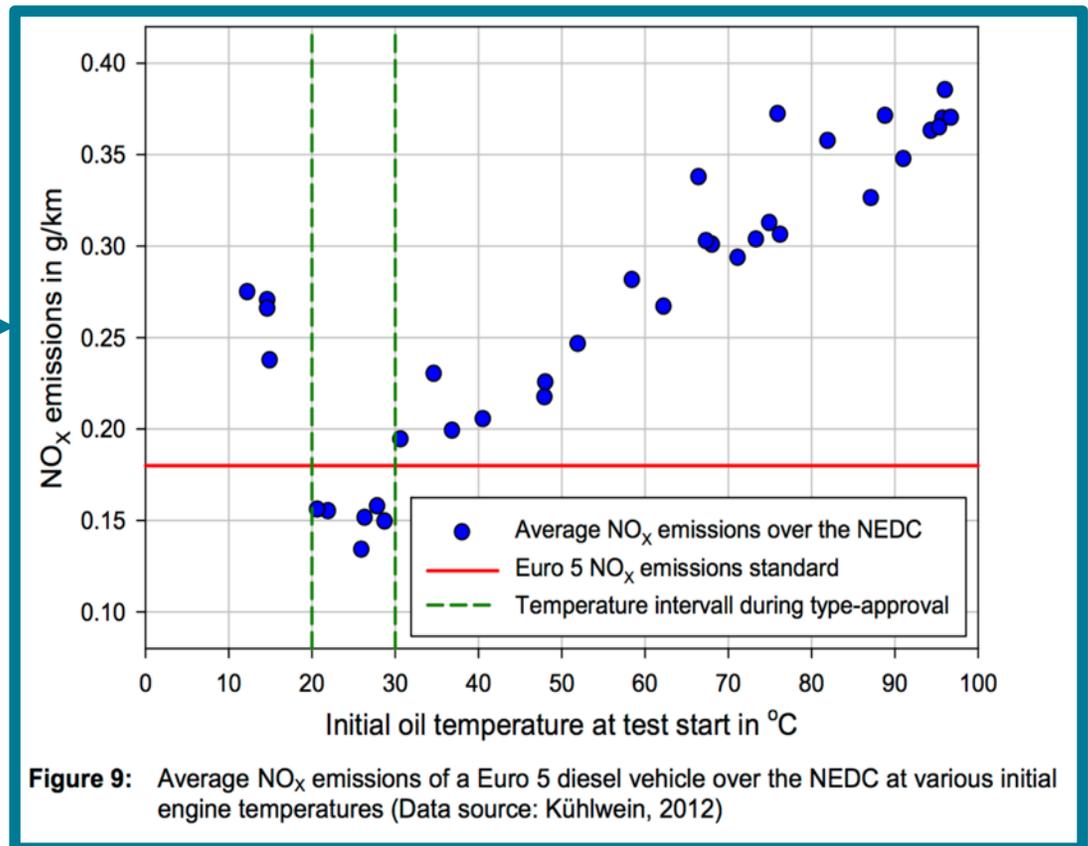
Type-approval cycle (NEDC) run on a track, and impact of ambient temperature

Euro 6 - NO_x results and limit



The list of discovered defeat devices is long and becomes longer, literally every few weeks

- Speed profile of the vehicle
- Steering wheel position
- Timer
- “Thermo-window”
- Maximum speed
- Altitude
- Engine speed
- Inclination
- ...
- New Euro 6 defeat devices
- ...
- Combination of several defeat devices



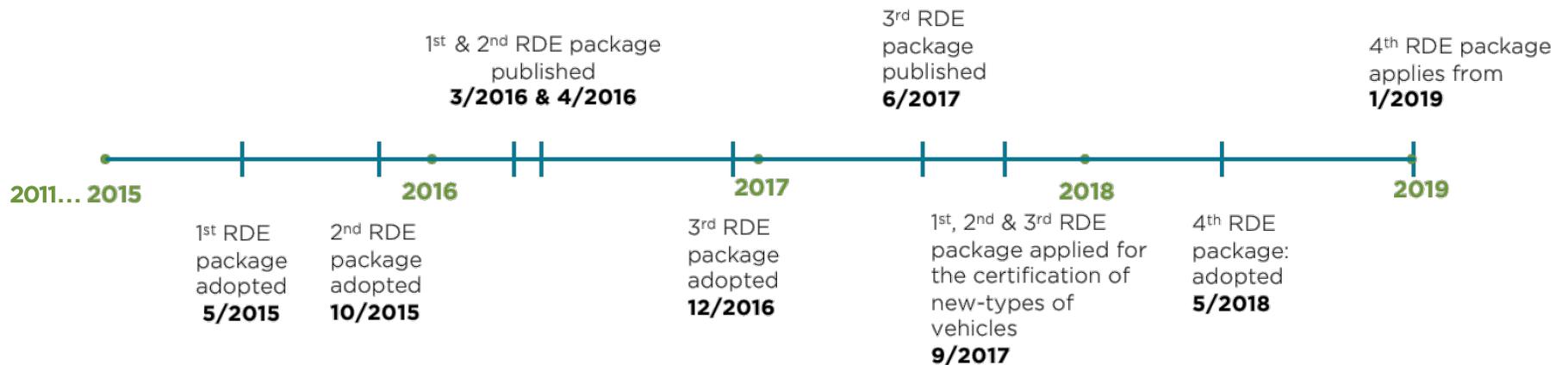
Source: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC75998/ld-na-25572-en-n_online.pdf

New testing procedure and its effect on vehicles real-world emissions

Development of the Real Driving Emissions test in Europe

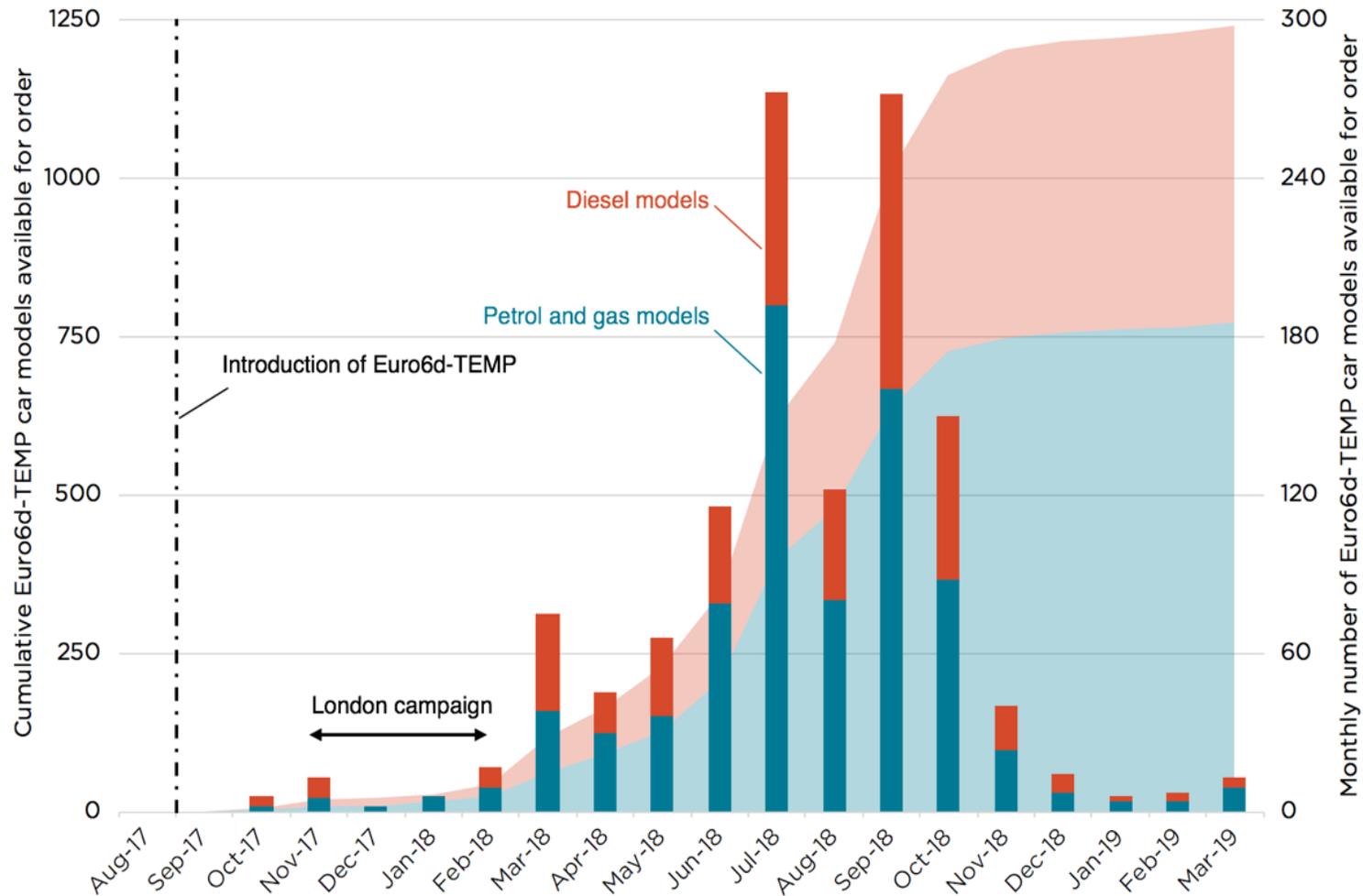
We came a long way...

Discussions to implement an on-road procedure for regulatory purposes started back in 2011 with the main objective **to reduce NO_x emissions under real-driving conditions**



- Package #3 (voted December 2016)
 - **Setting an on-road limit for PN, Sept. 2017** (new Gasoline Direct Injection vehicles)/ **Sept. 2018** (all Gasoline Direct Injection vehicles)
 - **Includes provisions for cold start testing**
- Package #4 (voted on May 3rd 2018)
 - **New emissions evaluation method**
 - **In-Service Conformity testing (ISC)**
 - **Granting-type approval authorities have to perform ISC**
 - **Third-parties may contract accredited laboratories to perform ISC**

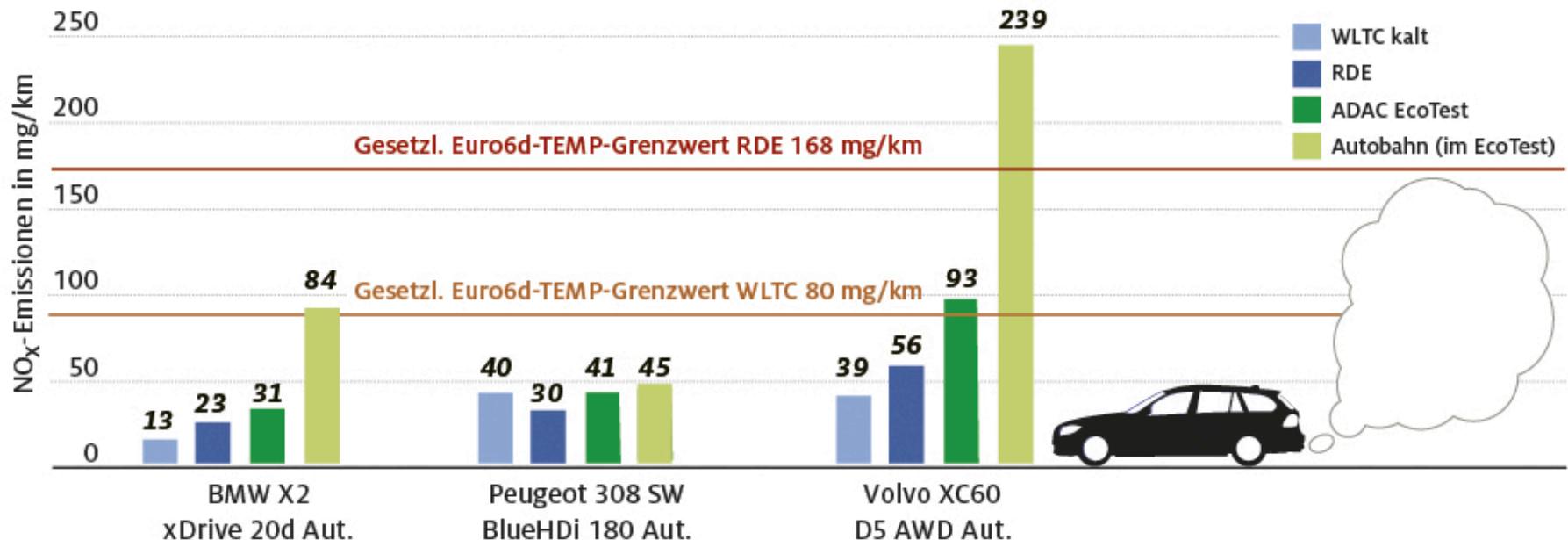
How about latest vehicles certified to the Euro6d-TEMP regulation?



Expected cleaner Euro6d-TEMP are coming, but vehicle introduction is done at a low pace

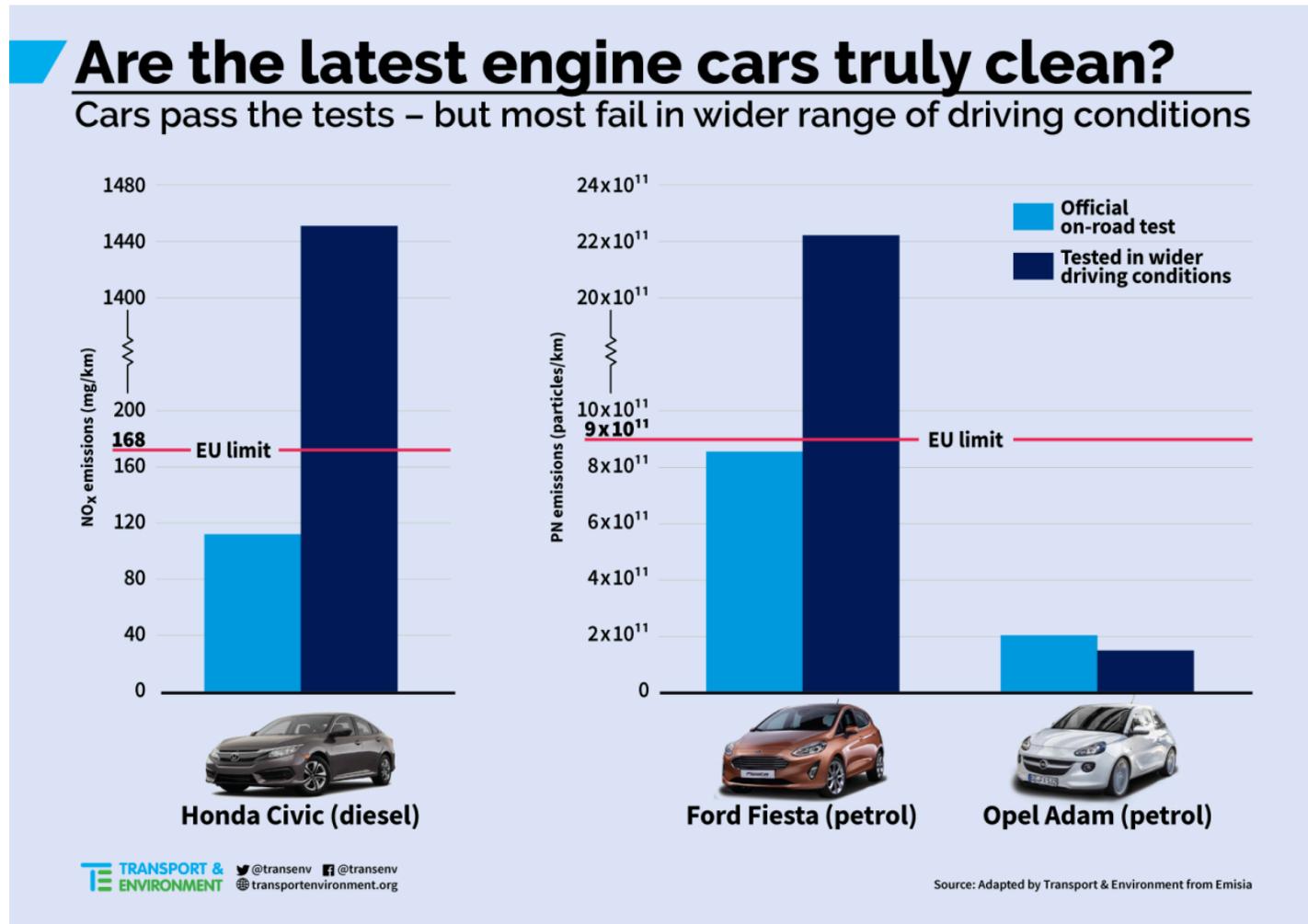
How about latest vehicles certified to the Euro6d-TEMP regulation? Some encouraging results...

NO_x-Ausstoß in den EcoTest-Messungen



First available Euro6d-TEMP tested by ADAC show NO_x levels under the Euro 6 laboratory limit for RDE testing. But under ADAC customized motorway test, one vehicle emits NO_x 3x higher than the emission limit.

How about latest vehicles certified to the Euro6d-TEMP regulation? ...some disappointing results



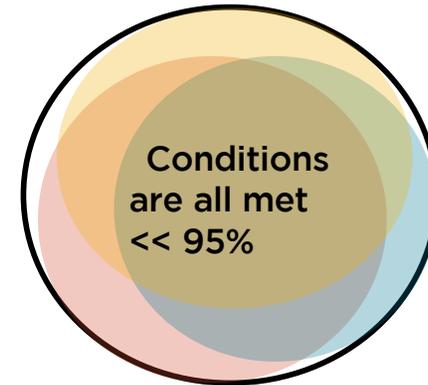
Under dynamic driving conditions not covered by the RDE regulation, NO_x, PN and CO emissions exceed the standard limit by several times.

Limitations of the Real-Driving Emissions (RDE) test procedure

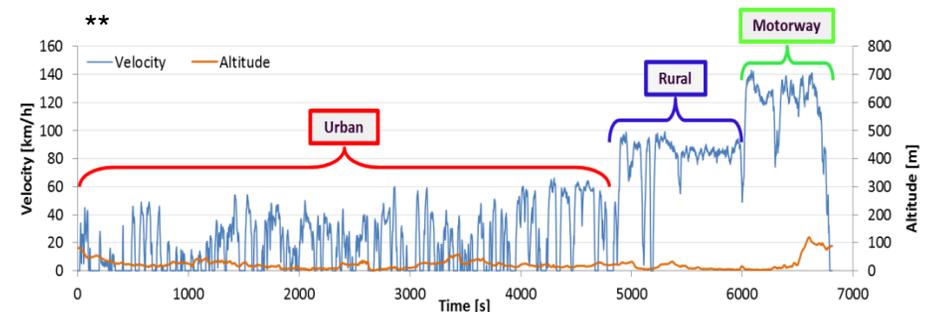
- Each testing boundary is designed to cover 95% of its occurrence in the real world:
 - But exceeding one of them leads to a failed test.
 - Eventually much less than 95% of all driving may be within the combined boundaries of RDE*

- Not defeat-device proof* (like any other defined testing protocol)
 - Relatively easy to predict: fixed sequence of the test, max speed, altitude, temperature, etc.
 - Enforcement is essential

- Does not limit every regulated emission component
 - CO, CO₂ (although already measured)
 - HC, PM
 - + N₂O, CH₄ (China 6)



Schematic illustrating 3 boundaries covering less than 95% of the "world" each. In reality the RDE regulation sets more than 10 different boundary conditions designed to cover 95% each.



Pollutant	Mass of oxides of nitrogen (NO _x)	Number of particles (PN)	Mass of carbon monoxide (CO)
Temporary CF	2.1	1 + margin PN, with margin = 0.5	- ?
Final CF	1 + margin, with margin = 0.43	1 + margin PN, with margin = 0.5	- ?

Conformity factor defined in the RDE 4th package (voted on May 3rd 2018)

*Source TNO 2017 R10862: [Assessment of risks for elevated NO_x emissions of diesel vehicles outside the boundaries of RDE](#)

**Source ICCT: [Real-world emissions testing on four vehicles](#)

Stronger market surveillance and enforcement from 2020

New EU Type-Approval Framework legislation will provide new provisions for enforcement and market surveillance

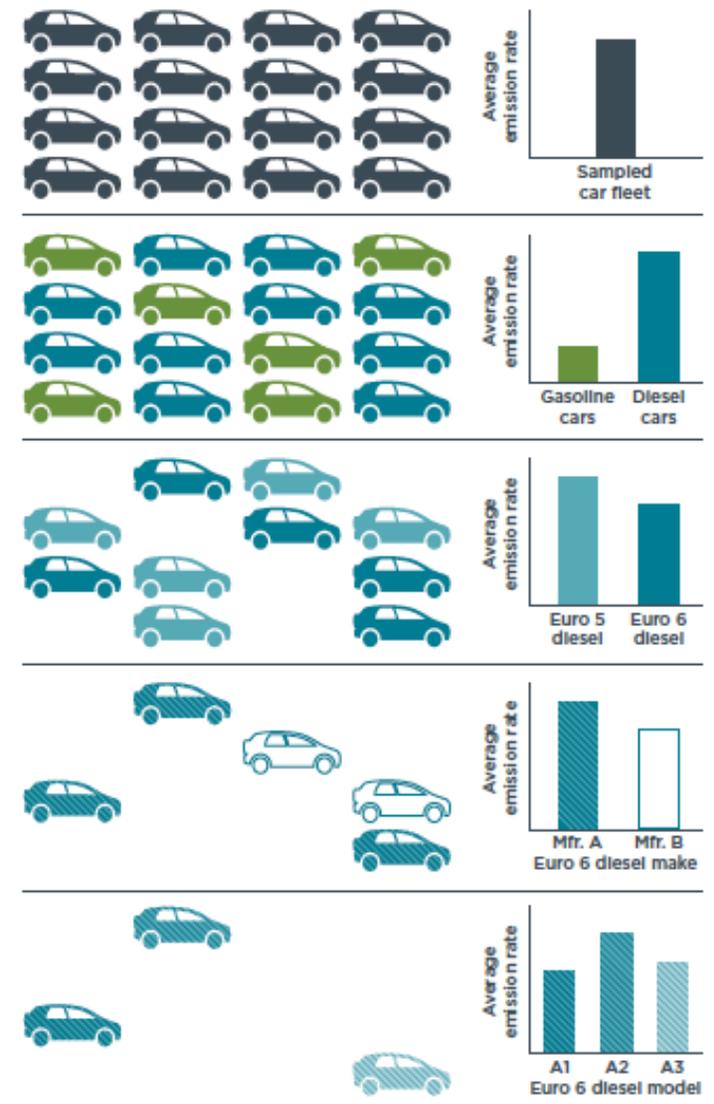
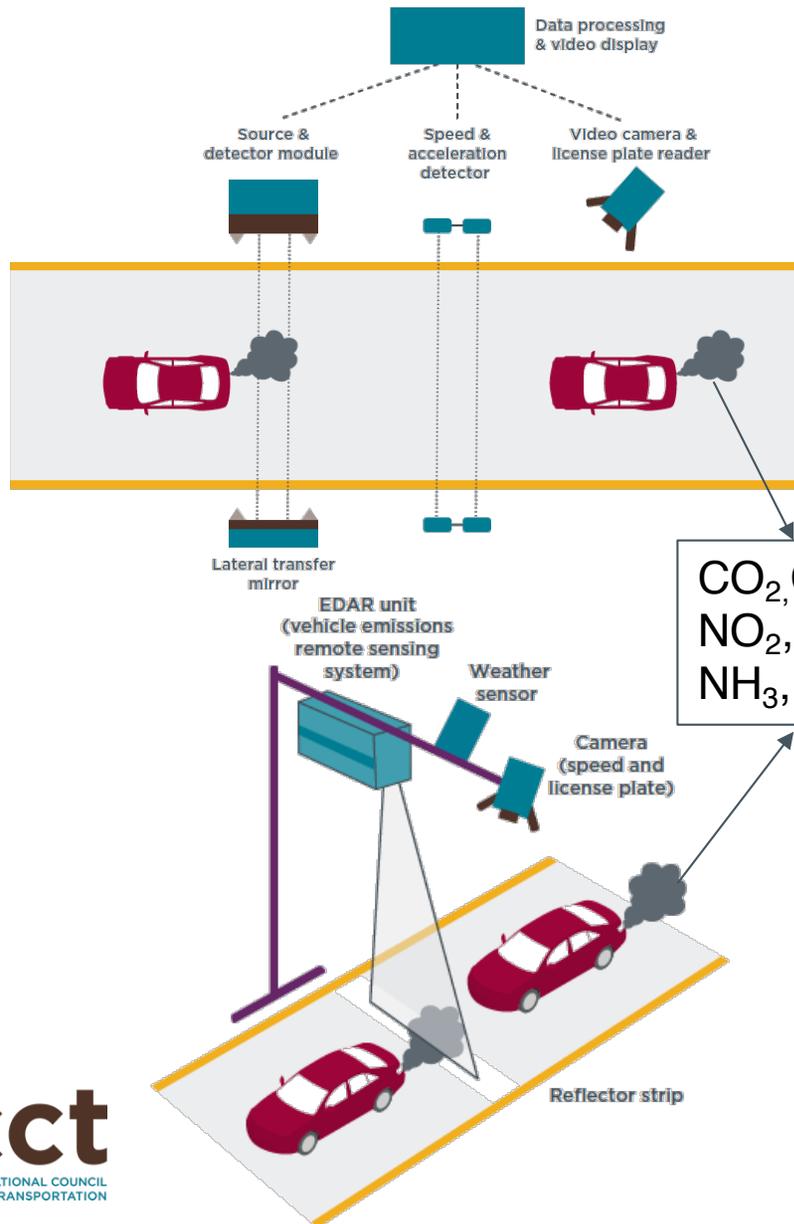
While it largely maintains the basic architecture of the EU type-approval system:

- Environmental Commission may carry out its own verification testing and initiate vehicle recalls
- Introduces independent market surveillance
- Member states will be allowed to restrict or prohibit the usage of affected vehicles or require actions by the manufacturer, even if certified by a different member.

European Council, Council of the European Union, "Approval and market surveillance for cars," March 2018.

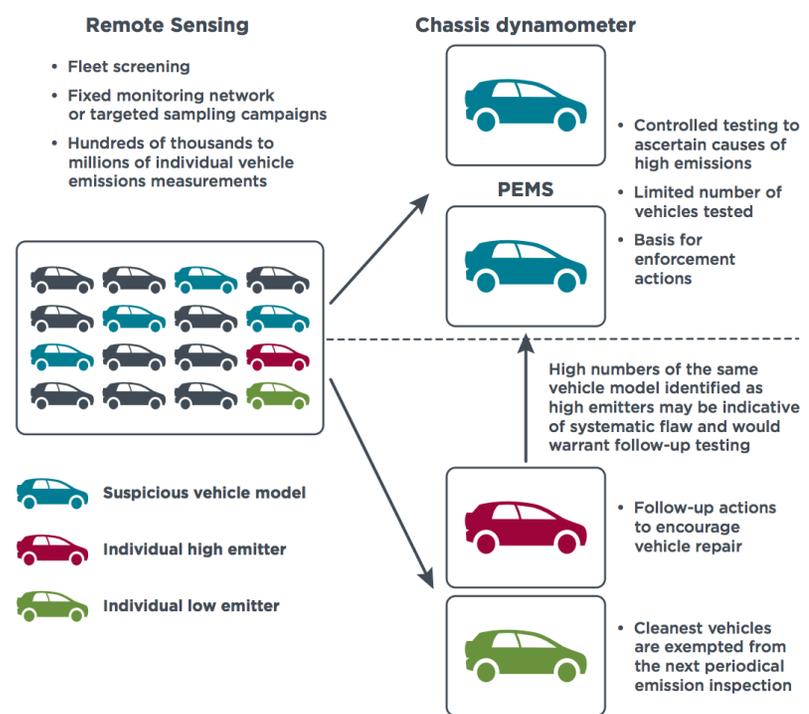
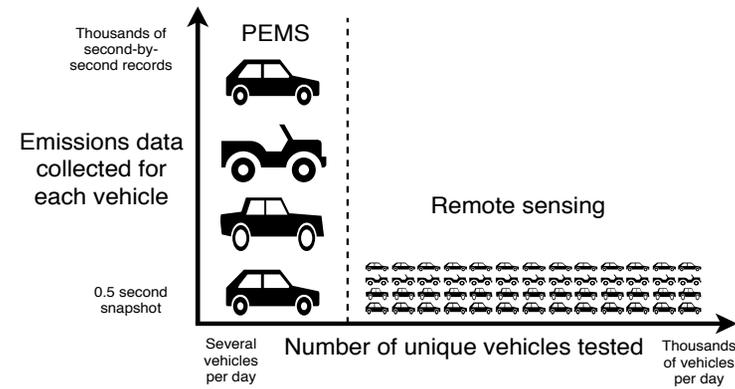
Retrieved from <http://www.consilium.europa.eu/en/policies/type-approval-for-cars/>

Market surveillance can be supported by “impossible-to-cheat” remote-sensing testing



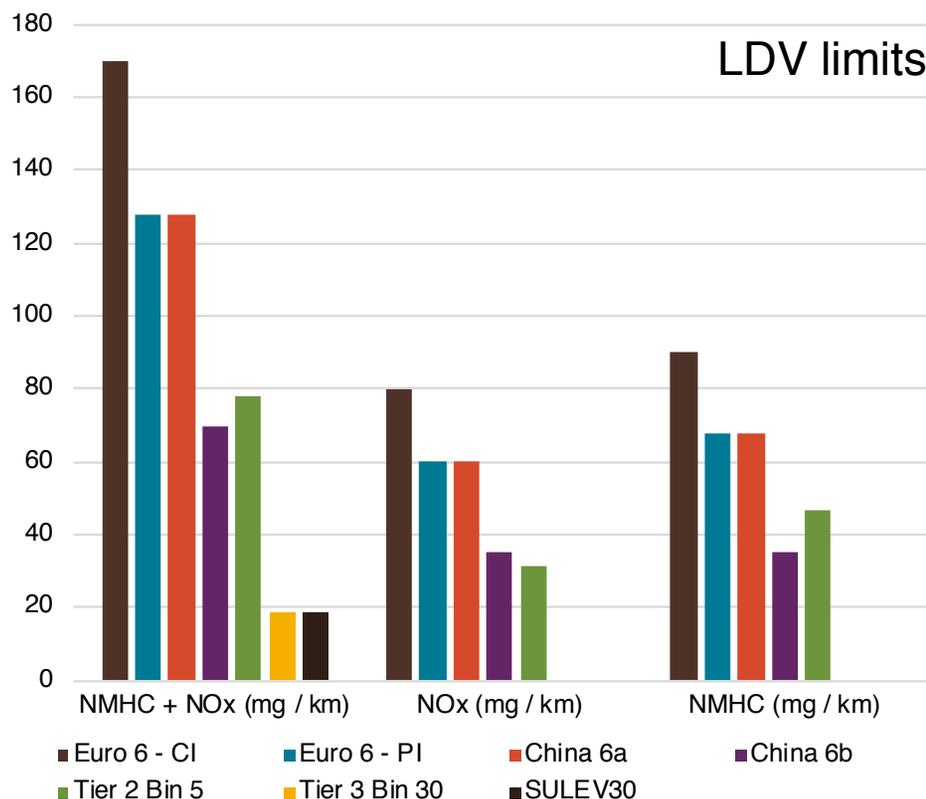
Remote sensing can also support in-use conformity screening, emission deterioration monitoring, recall effectiveness evaluation, tampering detection, periodical inspections, etc.

- Measure large number of vehicles in seconds → several thousand in a few weeks
- Measure emissions when vehicles are in real-world operation
- Non-intrusive to traffic
- Relatively difficult to detect (cheat)
- A complimentary tool to PEMS testing
- Grouping by vehicle family can identify worst emitters for more in-depth investigations
- Cost-effective



Perspectives on vehicles real-world emissions and the need for a Euro 7 regulation

Many countries follow EU emission standards – Europe should be the shining example



- EU limits are not fuel neutral. Diesel engines get a less stringent limit for NO_x and indirect injection gasoline engines are excluded from PM and PN limit.
- Diesel engines are not tested for -7 °C
- Euro 6, even for gasoline engines, is the least stringent regulation for NMHC and NOx compared to Tier 3 Bin 30, and China 6b.
- China 6b will be implemented in 2023. Tier 3 fully phased-in by 2025*.

A new Euro 7 is expected in the upcoming years, shall be fuel/technology neutral and to catch up with US and China

Currently unregulated pollutants under Euro 6

Particulate Mass (PM) and number (PN)

- Particles below 23 nm
- PM and PN emissions of indirect injection gasoline or gas engines

CO under real-world conditions (RDE)

- Indicator for incomplete combustion and/or catalytic conversion
- Coincides often with high HC emissions

NH₃:

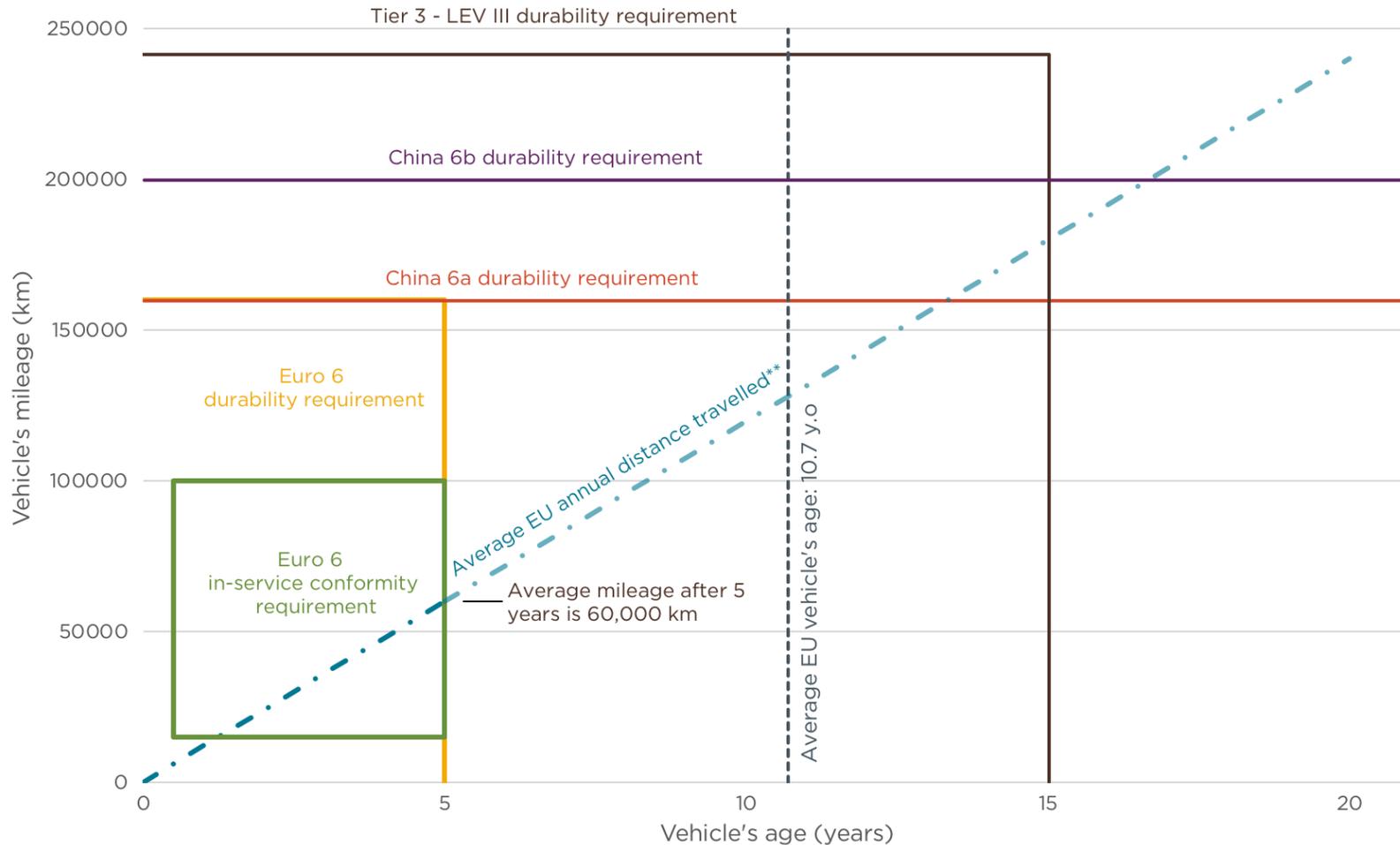
- Is a precursor to ultra-fine particles
- Euro 6 technologies have potential for high NH₃ emissions

N₂O and CH₄:

- Have a strong global warming potential
- CH₄ is a precursor to Ozone
- US and China set direct limits or account for as CO₂ equivalence
- Direct emission limit or as CO₂ equivalent

Non-engine related emissions (breaks, tires, Heating Ventilation and Air Conditioning...)

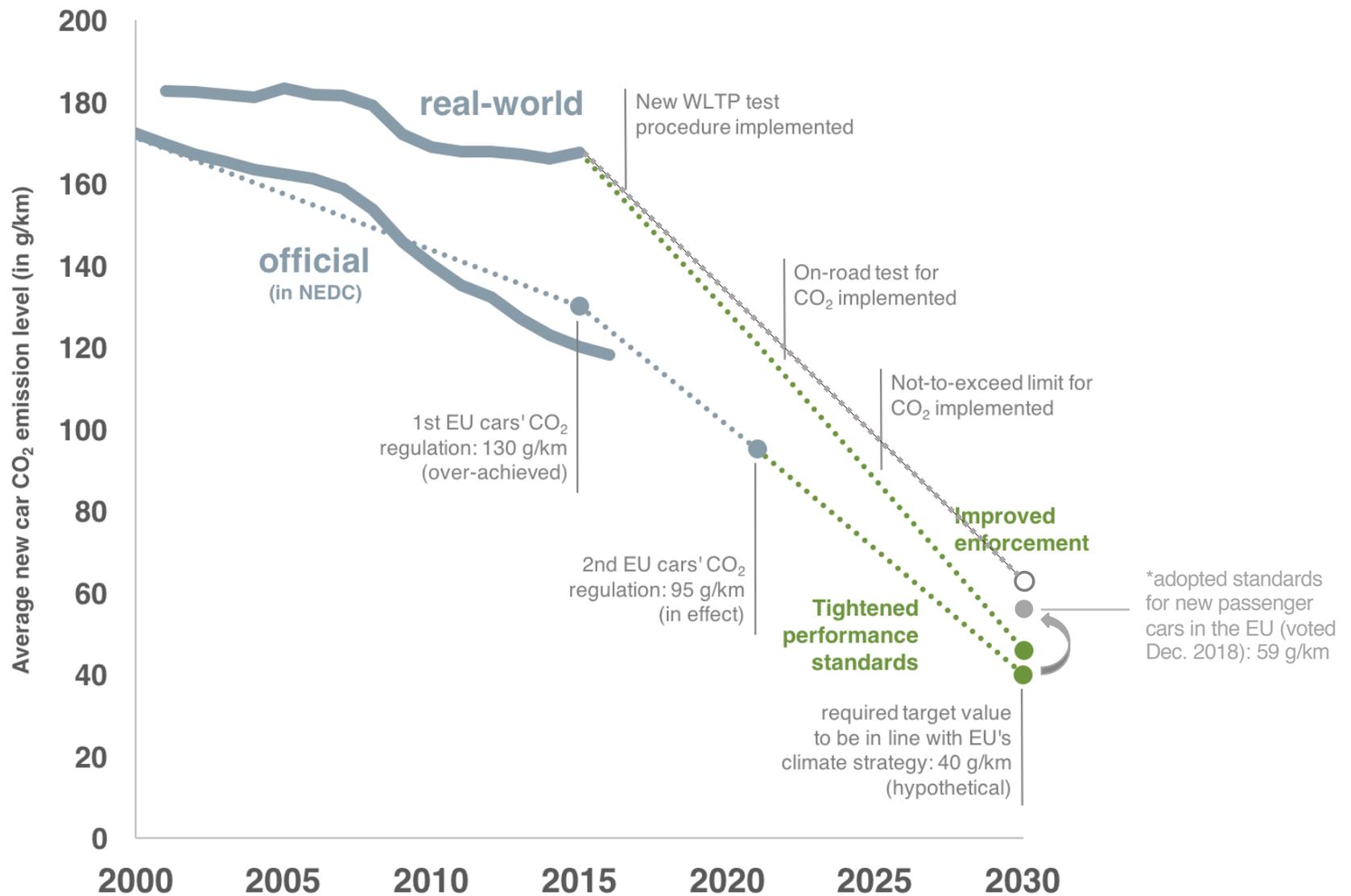
In-service conformity and durability requirements are too limited compared to average age of the EU fleet



Average age of vehicles in EU is 10.7 years old, 7.8 years old in Belgium, and more than 17 years old for some EU country (e.g. Poland)*

Emission standards are undermined if emission controls are allowed to rapidly deteriorate

Next generation of vehicles in the EU will have to meet more stringent CO₂ standards



Summary

- The majority of diesel vehicles currently in the fleet are still emitting way over the regulated limits
- RDE / Euro6d–TEMP and 6d vehicles are expected to bring significant lower pollutant emissions but not in all driving conditions and air pollution benefits will come at a low pace
- New regulatory provisions and measuring techniques for enforcement are coming from 2020
- Euro 6 pollutant limits are lagging behind US and soon China
- Euro 7 is the opportunity to design a flawless regulation
- In a context where CO₂ emissions have to decrease significantly in the next decade, vehicles using internal combustion engines will face significant challenges to comply with regulatory emission targets while remaining competitive against zero emissions vehicles.