



# The 3<sup>rd</sup> RDE legislation

4<sup>th</sup> July 2016

European Commission – DG-GROW

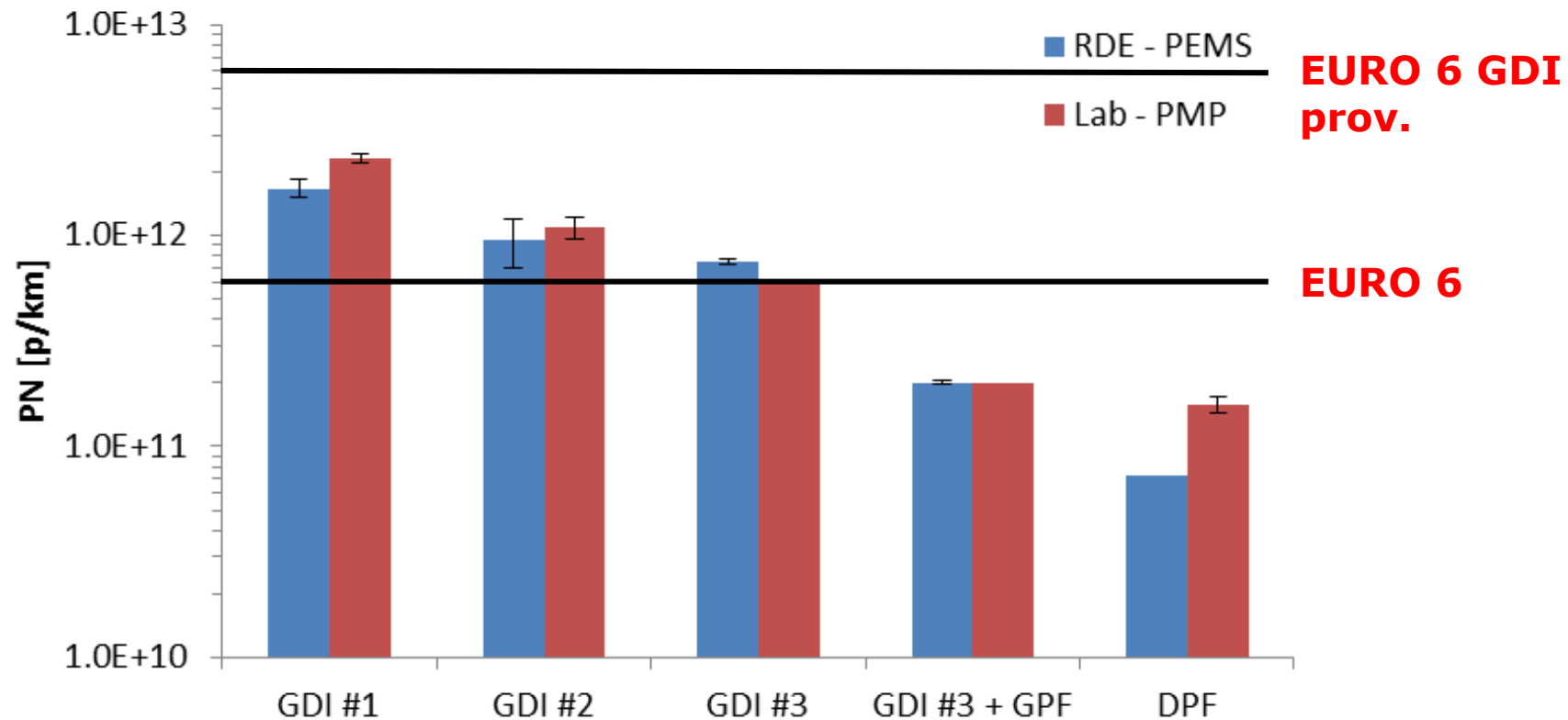
# Issues for RDE 3

- **PN-PEMS**
- **Cold start**
- Hybrids, Regeneration and Other issues

## PN at RDE

- Already included in **Regulation (EC) 459/2012** in footnote of table with EURO 6 limits:  
"(3 ) Until three years after the dates specified in Article 10(4) and (5) for new type approvals and new vehicles respectively, a particle number emission limit of  $6,0 \times 10^{12}$  #/km shall apply to Euro 6 PI direct injection vehicles upon the choice of the manufacturer. Until those dates at the latest a type approval test method ensuring the ***effective limitation of the number of particles emitted by vehicles under real driving conditions*** shall be implemented."
- Dates are set already in legislation as **1 Sept. 2017 for new types** and **1 Sept 2018 for all vehicles**
- ***This is currently under review by the legal officers***

# Current situation with PN (PMP vc RDE)



# PN-PEMS Measurement uncertainty

PN-PEMS vs	Theory	1 lab – many cars**	1 car – many labs**
PMP_TP	<25%	<35%	<40%
<b>PMP_CVS</b>	<b>&lt;50%*</b>	<b>&lt;50%</b>	<b>&lt;55%</b>
TP vs CVS (PMP)	<30%	<40%	<35%

\* Assuming 25% effect of sampling location (losses + exhaust flow uncertainties)

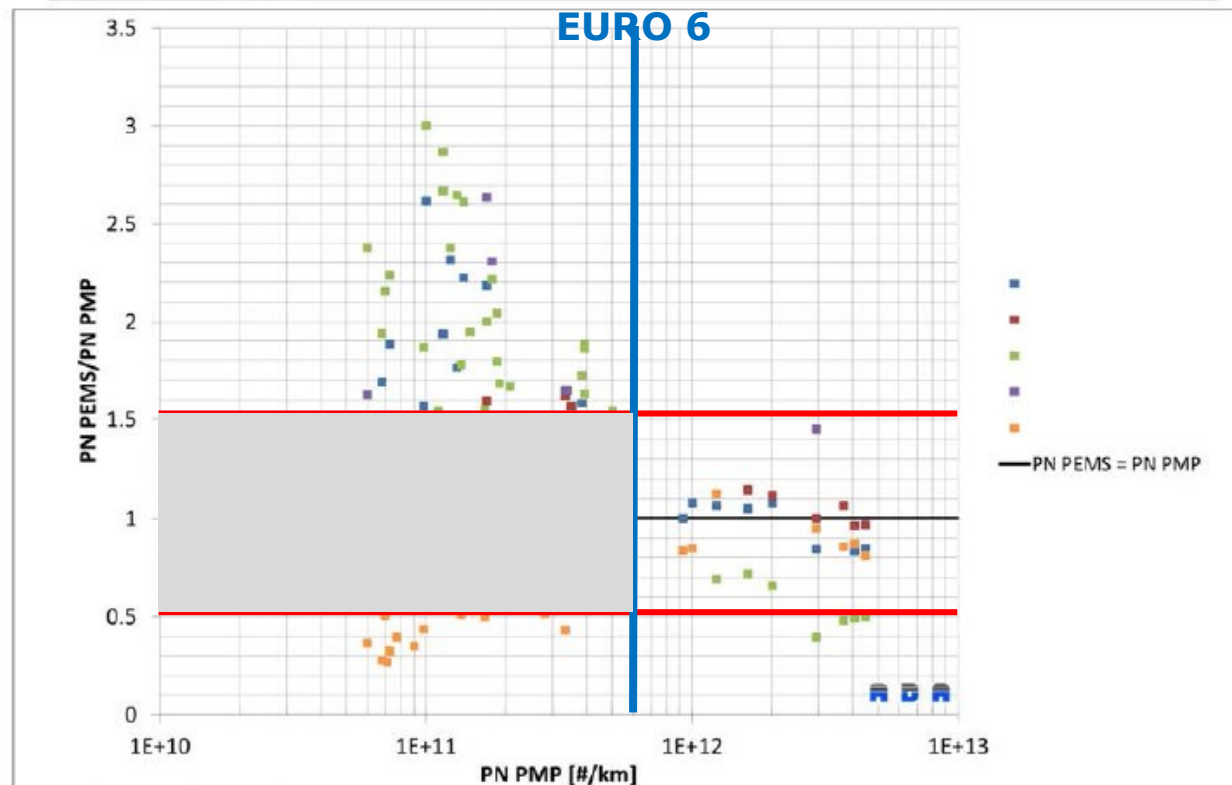
\*\* Based on worst case of two reference systems (DC and CPC based)

**Numbers are the worst case for all cases examined (i.e. they are max values) close to the EURO 6 PN limit**

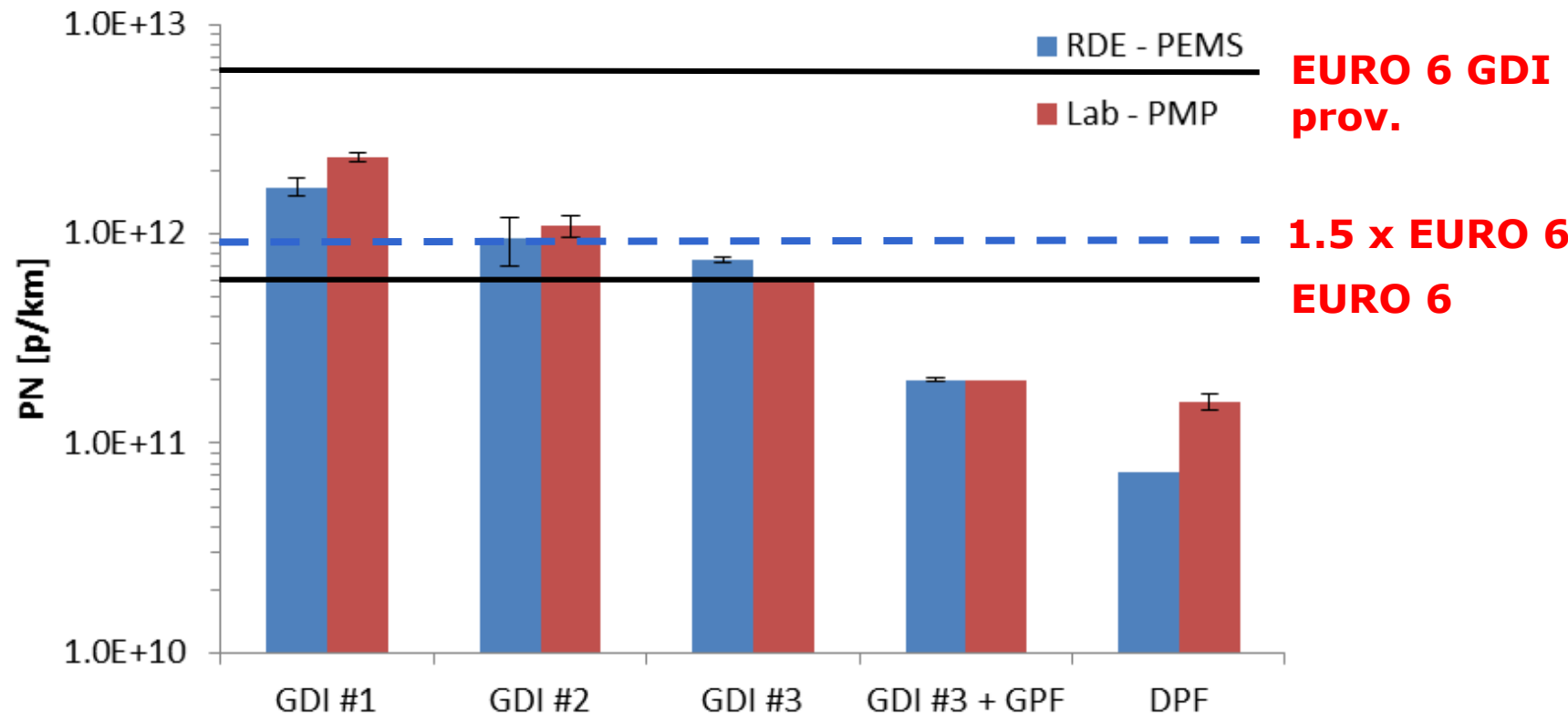
# From ACEA data



Einfluss der kumulierten PMP-Partikelanzahl



# Current situation with PN (PMP vs. RDE)



## Current EC Proposal for PEMS-PN

- Inclusion of PN for RDE is technically feasible
- Equipment fulfil the technical specifications and have shown good behaviour during extensive testing
- Since technology exists (GPF) that allows even GDIs to be significantly lower than the EURO 6 limits, only the measurement uncertainty may be allowed
- Theory and the most extensive set of data available (JRC interlab and own tests) show that the uncertainty of measuring at the EURO 6 limit is at maximum 50% (*for good equipment even less*)
- **CF<sub>PN</sub>: 1.5 in 2017 for new types, in 2018 for all vehicles**
- **With a review clause since equipment are bound to improve**



# COLD START

The issue of cold start contains inherently two issues:

- **Engine start** (i.e. inclusion of first minutes of test into the evaluation)
- **Start of the vehicle in cold atmospheric conditions**

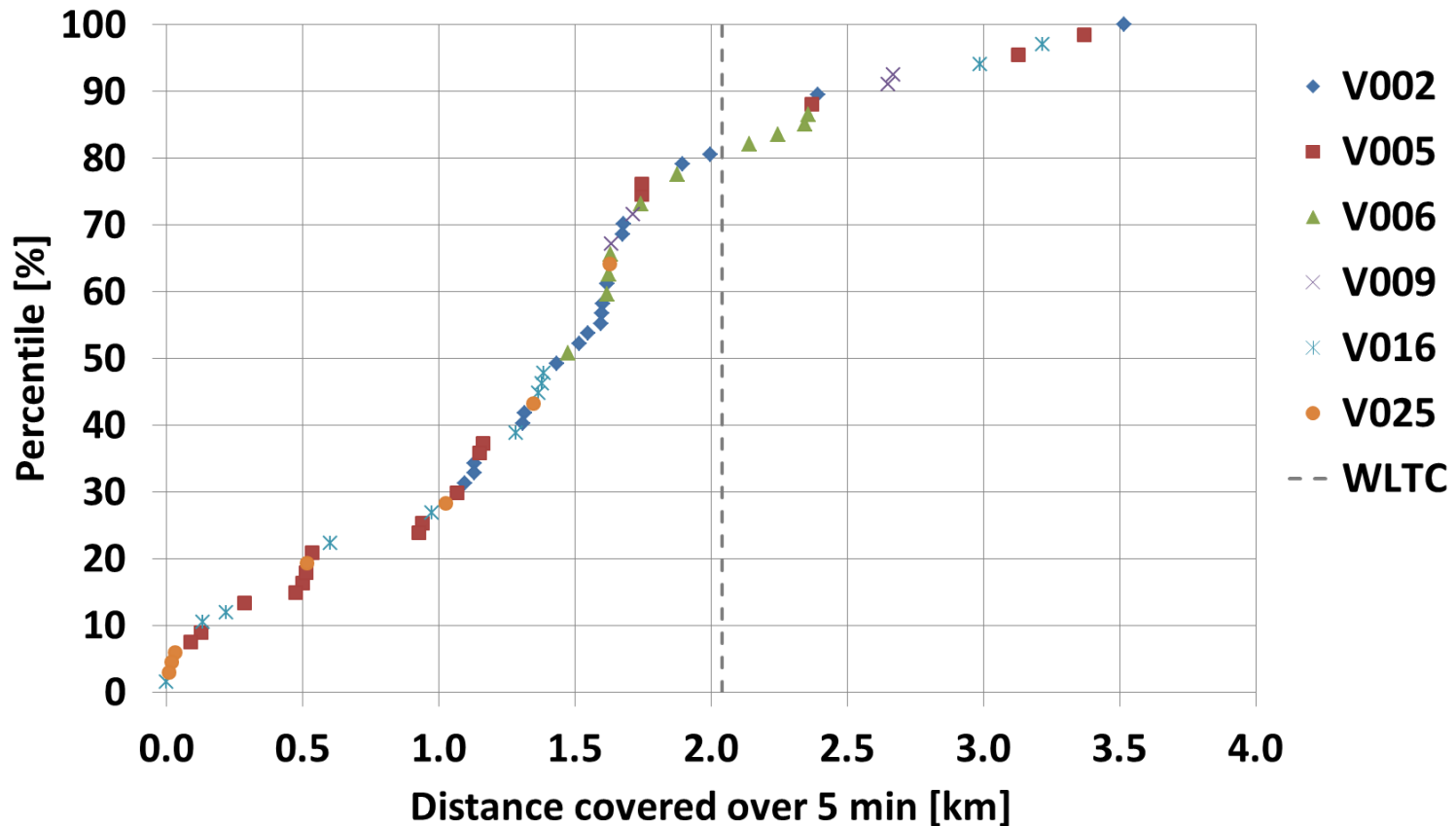
Currently Cold start emissions are recorded in RDE but excluded from calculations

- Absence of vehicle conditioning
- Low repeatability and reproducibility of test conditions may lead to high variability of warm-up durations and cold start emissions
- Cold start contributes little to the overall emissions of comparatively long (up to 2h) RDE tests

# Current Boundary conditions



- Currently potentially large variability of driving in the first 5 min



# RDE 3 Boundary conditions



Adaptations are needed for a robust assessment of cold-start emissions:

- **Soak** of vehicle overnight at ambient T
  - Issue to solve with PEMS equipment (better isolation?, overnight inside?)
- **Mandatory start of trips with urban driving** (revision of Point 6.2)
- **Limiting idling at test start** (revision of Point 7.6)

Application of RDE urban boundaries to cold-start:

- **Cold-start driving at average speed 15-40 km/h**
- **$v^*a+$  and RPA boundaries of Appendix 7a**

# Approaches



- Approach 0: Cold-start as part of RDE urban evaluation

- Approach 1: 
$$M_{urban} \left[ \frac{mg}{km} \right] = \frac{m_{cold}[mg] + m_{hot}[mg]}{d_{urban}[km]} = \frac{m_{cold}[mg]}{d_{urban}[km]} + \frac{m_{hot}[mg]}{d_{urban}[km]}$$

$$M_{urban} \left[ \frac{mg}{km} \right] \approx \frac{m_{cold}[mg]}{d_{urban}[km]} + RDE_{hot,urban} \left[ \frac{mg}{km} \right]$$

- Approach 2a: 
$$M_{urban} \left[ \frac{mg}{km} \right] = w \cdot M_{cold} \left[ \frac{mg}{km} \right] + (1 - w) \cdot RDE_{hot,urban} \left[ \frac{mg}{km} \right]$$

$$\text{with } w = \frac{d_{cold}[km]}{d_{urban}[km]}$$

- Approach 2b: 
$$M_{urban} \left[ \frac{mg}{km} \right] = w \cdot M_{cold} \left[ \frac{mg}{km} \right] + (1 - w) \cdot RDE_{hot,urban} \left[ \frac{mg}{km} \right]$$

$$\text{with } w = \frac{d_{cold} = 2km}{d_{urban}[km]}$$

- T&E proposal of repeat of urban drive at end of RDE test

# Cold start for NOx



<b>NOx</b>	<b>JRC data at 15-40 km/h (6 tests)*</b>
<b>Approach 0 (CS part in normal RDE evaluation)</b>	<b>7 ± 11%</b>
<b>Approach 2a (<math>d_{\text{urban}} = \text{RDE}_{\text{urban}}</math>)</b>	<b>9 ± 4%</b>
<b>Approach 2a (<math>d_{\text{urban}} = 23\text{km}</math>)</b>	<b>15 ± 8%</b>
<b>Approach 2a (<math>d_{\text{urban}} = 8\text{km}</math>)</b>	<b>45 ± 22%</b>

\* Type of vehicles, T ranges (see next slide)

# Cold start for NOx



## Complementary information on cold-start analysis

- A total of 9 tests are used for the JRC cold-start analysis
- The six tests with an average cold-start speed of 15-40 km/h are marked in bold

Test ID	Vehicle information	Ambient temperature in °C
<b>V006_CI_2</b>	<b>Light-commercial vehicle, Diesel, SCR, DPF</b>	<b>14</b>
<b>V006_CI_3</b>	<b>Light-commercial vehicle, Diesel, SCR, DPF</b>	<b>16</b>
<b>V006_CI_4</b>	<b>Light-commercial vehicle, Diesel, SCR, DPF</b>	<b>13</b>
<b>V002_CI_2</b>	<b>Passenger car, Diesel, SCR, DPF</b>	<b>8</b>
<b>V002_CI_3</b>	<b>Passenger car, Diesel, SCR, DPF</b>	<b>8</b>
<b>V002_CI_4</b>	<b>Passenger car, Diesel, SCR, DPF</b>	<b>9</b>
V002_CI_5	Passenger car, Diesel, SCR, DPF	4
V005_CI_1	Passenger car, Diesel, De-NOx, DPF	7
V005_CI_2	Passenger car, Diesel, De-NOx, DPF	17

# Cold start for PN



PN	JRC RDE data (Golden Vehicle, GDI w/o GPF, av. 5 tests) CPC based PN-PEMS	JRC RDE data (Golden Vehicle, GDI w/o GPF, av. 9 tests) DC based PN-PEMS
Approach 0 (CS part in normal RDE evaluation)	7% (+/-7 %)	3% (+/-3 %)
<b>Approach 2a</b> ( $d_{\text{urban}} = \text{RDE}_{\text{urban}}$ )	<b>22% (+/-14%)</b>	<b>15% (+/-10%)</b>
<b>Approach 2a</b> ( $d_{\text{urban}} = 23\text{km}$ )	<b>36% (+/-24%)</b>	<b>22% (+/-16%)</b>
<b>Approach 2a</b> ( $d_{\text{urban}} = 8\text{km}$ )	<b>105% (+/-70%)</b>	<b>63% (+/-46%)</b>

\* Type of vehicles, T ranges

# Cold start for PN



## Complementary information on cold-start analysis

- A total of 10 tests are used for the JRC cold-start analysis all with an average cold-start speed of 15-40 km/h
- 5 of these test for the CPC based PN-PEMS and 9 for the DC based PN-PEMS

<b>Test ID</b>	<b>Vehicle information</b>	<b>Ambient temperature in °C</b>
20150916_road_03_JRC	Passenger car, GDI	17
20151022_road_01_HON	Passenger car, GDI	12
20151023_road_02_HON	Passenger car, GDI	13
20151120_road_03_VOL	Passenger car, GDI	4
20151123_road_04_VOL	Passenger car, GDI	3
20151208_road_04_TUV	Passenger car, GDI	12
20151218_road_02_JRC	Passenger car, GDI	6
20151221_road_04_JRC	Passenger car, GDI	10
20160112_road_01_JRC	Passenger car, GDI	12
20160113_road_02_JRC	Passenger car, GDI	12



# Engine Start Inclusion:

- Boundary Conditions to be included
- Approach 0: straight forward but not technically correct since we have under-sampling of the first min with EMROAD
- Approach 2A: Technically correct, but care needs to be taken to select the appropriate  $d_{urban}$
- EC still to decide on the best approach
- Dates for inclusion into RDE are with 1st step

# Ambient conditions are already present in current RDE:

- Moderate and extended RDE conditions (Point 5.2; Regulation 2016/427)
- Derogations apply until 5 years after Euro 6 dates

Ranges	In °C	Factor
Moderate temperature	0 to 30	1
<i>Derogation moderate temperature</i>	<i>3 to 30</i>	<i>1</i>
Extended temperature	-7 to <0 and >30 to 35	<b>1.6</b>
<i>Derogation extended temperature</i>	<i>-2 to &lt;3 and &gt;30 to 35</i>	<b>1.6</b>

## NEXT STEPS

- We realise that the timing is ambitious both for finalising the legislation and for implementing it
- Vote in TCMV planned for mid-November
- Text needs to be ready by early September
- Realistically the new legislation should be published after the WLTP one, in spring 2017
- First implementation date for new types is already in September 2017!



**THANK YOU FOR YOUR ATTENTION!**

**PLEASE DIRECT YOUR QUESTIONS TO  
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