

# Evaluation of exhaust emissions of vehicles with emission Euro 6 class according to RDE tests proposed by the European Union



Jacek Pielecha, Jerzy Merkisz  
Jarosław Markowski, Remigiusz Jasiński

Institute of Combustion Engines and Transport  
Poznan University of Technology, Poland



## Abstract

New test procedures for determining exhaust emissions from passenger vehicles will be introduced in 2017. For several years, the European Commission is developing new procedures, which aim is to perform tests under road conditions. The purpose is to determine the real value of emissions, which do not always reflect the level of emissions in the laboratory. Proper and accurate procedures for determining emissions in real traffic conditions (RDE – Real Drive Emission) have not yet been approved (as opposed to Heavy-Duty Vehicles for which such conditions already exist), but there are proposals that are currently analysed by major research centers in Europe. There are many differences between those proposals such as determining road emission or research methodology related to emission measurement of hydrocarbons.

The work compares the results of emissions measured in road tests using the latest legislative proposals related to passenger cars. The results are shown in relation to the used measurement method:

- classic method of determining exhaust emission; uses all measurement data determining the mass of harmful compounds and distance travelled during the test,
- method of averaging the measuring windows (MAV – moving average windows), also in the literature called **EMROAD** method, which determines the measurement windows (on the basis of carbon dioxide emissions from the WLTP test) and on its basis determines the road emission in RDE test,
- generalized method of instantaneous power (**Power Binning**), known in the literature as **CLEAR** – Classification of Emissions from Automobiles in Real driving, determines road emissions on the basis of generalized instantaneous power during the RDE test.

## EU Emission Legalisation Roadmap

2015	2016	2017	2018	2019	2020	2021	2022	
Euro 6b			Euro 6c			Euro 6d		
NEDC			WLTC					
Development and measurement phase			Conformity Factor (CF)				CF <sub>NOx</sub> = 1.5	
			CF <sub>NOx</sub> = 2.1					
RDE for CO, NO <sub>x</sub> , PN emissions:			EC 427/2016 and EC 646/2016					CO, NO <sub>x</sub> , PN and CO <sub>2</sub> ???

## RDE-LDV Trip Requirements

### Overall

- The trip sequence shall consist of urban driving followed by rural and motorway driving
- The trip duration shall be between 90 and 120 minutes
- The start and the end point shall not differ in their elevation above sea level by more than 100 m

### Urban



- Vehicle speed (V): 0 ≤ V < 60 km/h
- Distance based: ~34% (±10%)
- Min. distance: 16 km (min. distance based > 29%)
- Average speed (inc. idling): 15 – 30 km/h
- Less than 1 km/h for at least 10% of the urban driving time
- Long stop period (> 80% of the total stop time of urban operation) shall be avoided

### Rural



- Vehicle speed (V): 60 ≤ V < 90 km/h
- Distance based: ~33% (±10%)
- Min. distance: 16 km

### Motorway

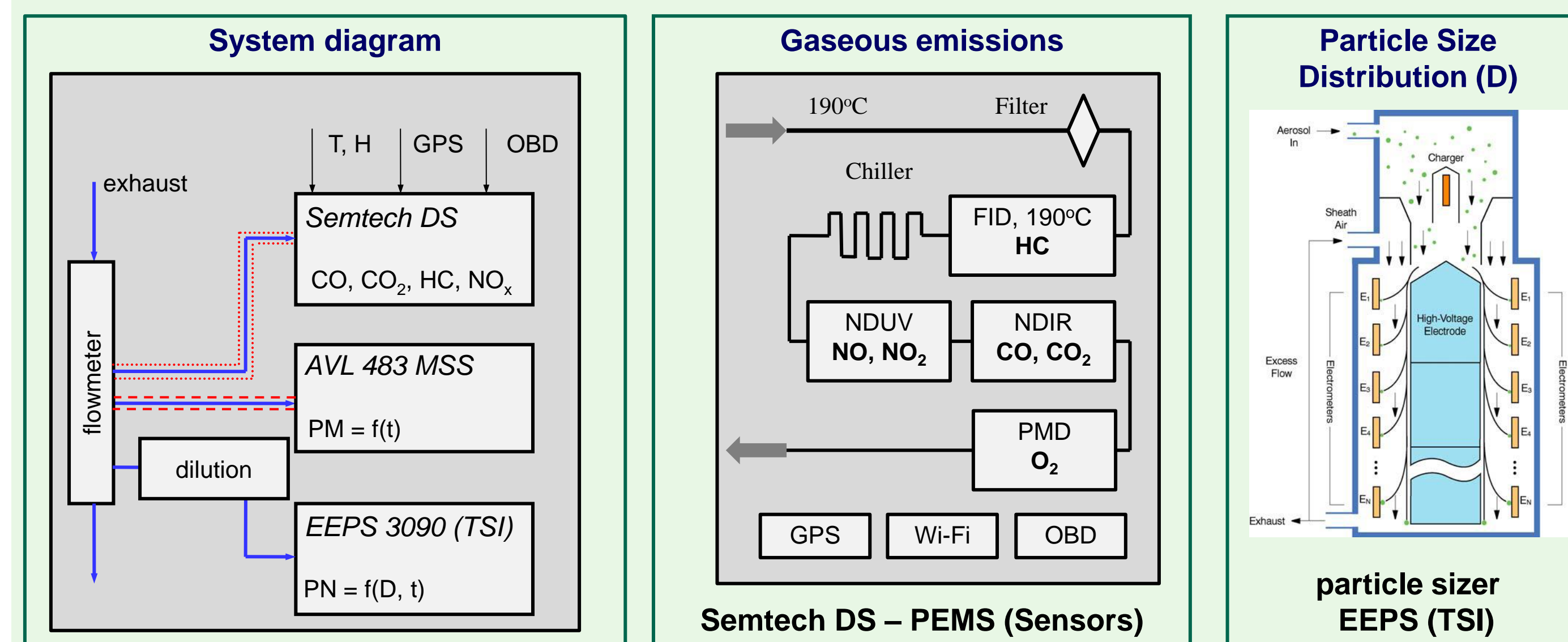


- Vehicle speed (V): V ≥ 90 km/h (90 – 110 km/h)
- Distance based: ~33% (±10%)
- Min. distance: 16 km
- Above 100 km/h for at least 5 minutes
- Max speed 145 km/h (130 km/h with a tolerance of 15 km/h for not more than 3% of the time duration of the motorway driving)

Special thanks to **ERMES** and **JRC** for providing the **EMROAD** and **CLEAR** software.

The research was funded by the National Centre for Research and Development (Narodowe Centrum Badań i Rozwoju) research project within the **INNOCHEM** Programme (Contract No. **INNOCHEM-K2/IN2/36/182269/NCBR/12**).

## PEMS System

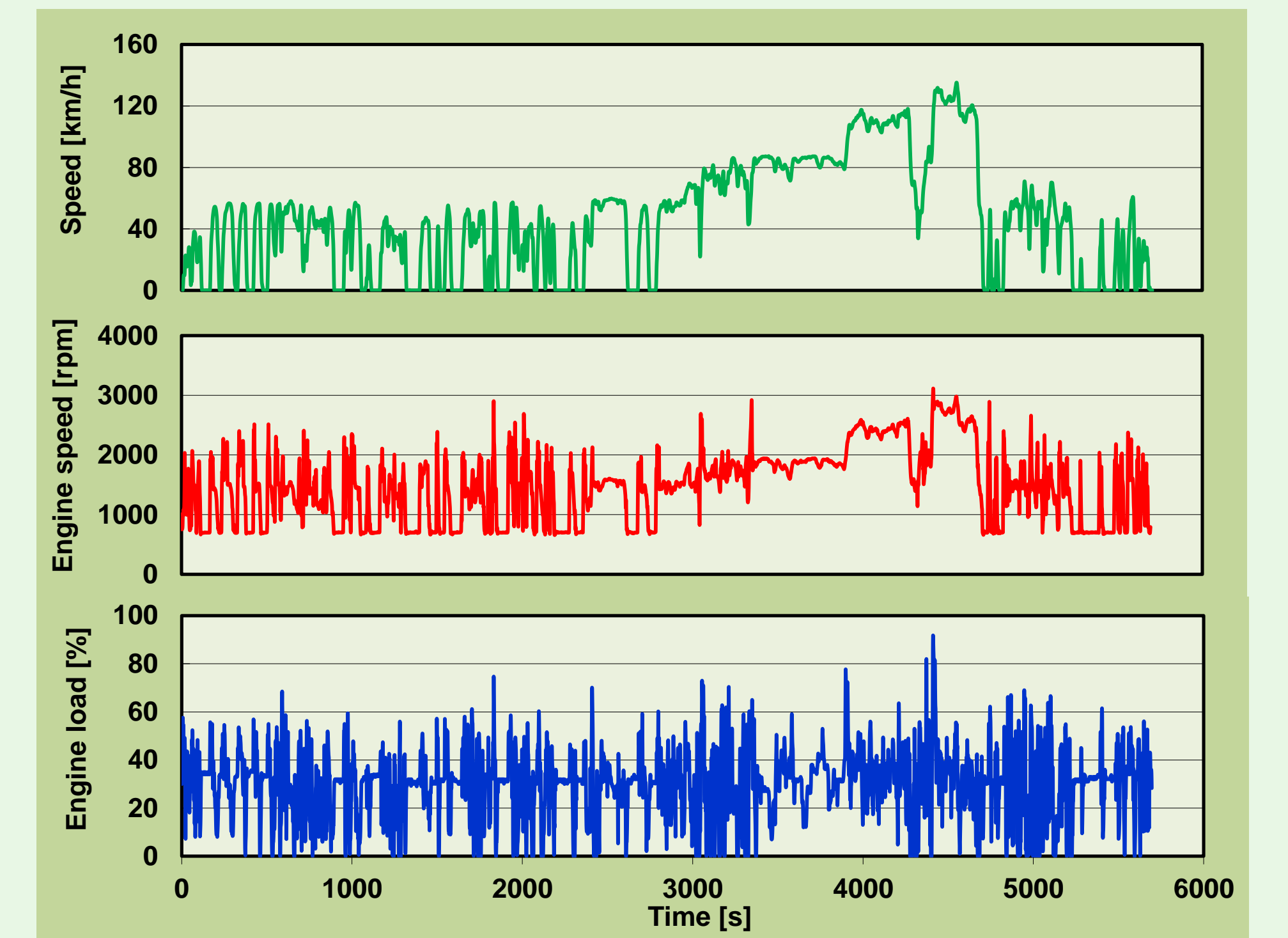


5 x Diesel – Euro 6c (MY 2015&2016)  
6 x Gasoline – Euro 6 (MY 2015)

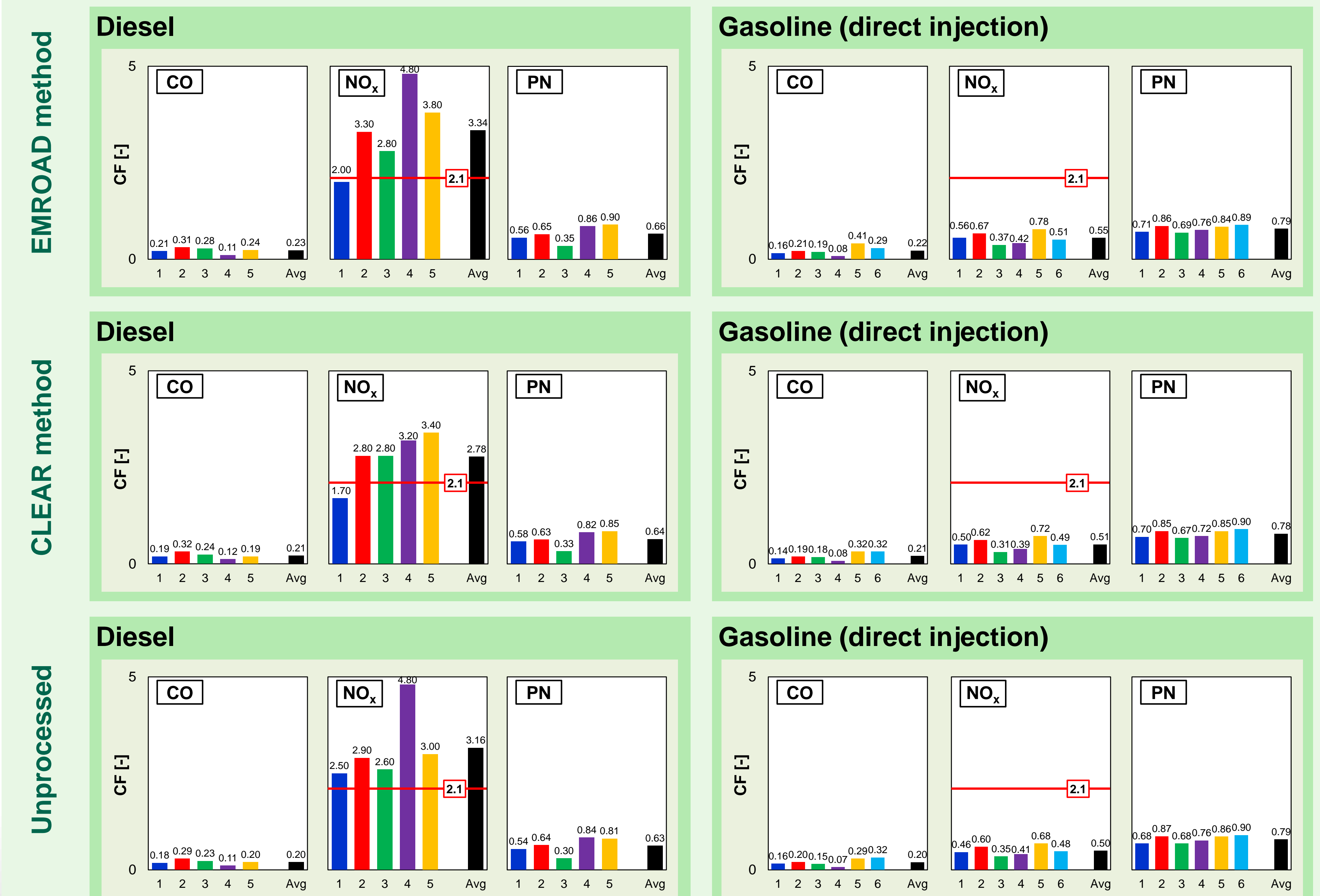


## Trip Requirements (example)

TRIP CHARACTERISTICS	Urban	Rural	Motorway	Total
Trip distance	> 16 km	> 16 km	> 16 km	
	31.24	22.91	20.62	74.78
Total trip duration				90-120 min
				95
Cold start duration				min 5 min.
				5
Distance share	29-44%	23-43%	23-43%	
	41.78	30.64	27.58	100.00
Average speed	15-40 km/h	78.34	114.23	47.25
	28.16			
Motorway speed above 145 km/h			< 3%	
			0.00	
Motorway speed above 100 km/h			≥ 5 min	
			10.45	
Urban stop time				6-30%
				26.54
Start and end points elevation absolute difference				<= 100 m
				6.00
Overall trip dynamics	0.17	0.06	0.05	
95th percentile Speed*Acc	10.01	10.63	20.79	



## Results



## Summary

In road tests conformity factors (CF) – depending on the applied technical solutions – for gasoline engines with direct injection for emissions class Euro 6 are less than 1. Values of the conformity factors for vehicles with Diesel engines look otherwise: a road tests have shown that the values of the conformity factors of carbon monoxide are less than 1 (meet the standard), whereas the emission of oxides of nitrogen were obtained between CF<sub>NOx</sub> = 1.7–4.8 (according to the classical method: CF<sub>NOx</sub> = 2.5–4.8, according to the MAV method – CF<sub>NOx</sub> = 2–4.8; and the CLEAR method – CF<sub>NOx</sub> = 1.7–3.2). Also, same situation applies to the determination of particulate emissions; in terms of number, conformity factors reached CF<sub>PN</sub> = 0.3–0.9 (all methods).