



# In-Use Emissions Testing Developments in the New and Future European Motor Vehicle Emissions Regulations

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- *Emissions regulations are and should remain a core policy instrument to check and limit the environmental and health impact of vehicles.*
- *Regulations moves towards the control of GHG emissions limit global warming.*
- *The EU regulates energy consumptions and emission of road transport with a comprehensive legislative framework developed in the last 35 years.*
- *Move from laboratory environment with specified conditions (engine/vehicle test cycles) towards emissions as they occur during vehicle operations.*
- *Using portable instruments (PEMS) has made this shift possible.*
- *First introduced to verify the conformity of HD engines with emission limits during normal life. (EURO VI heavy-duty engines (Commission Regulation 582/2011, Protocols for ISC in Annex II))*
- *Using portable instruments (PEMS) to check the emissions avoids the extraction of the engines from machines, check functionality of the emissions control technologies and an implicit protection against defeat strategies.*





- *End 90s until 2003: US-EPA first rules and preliminary instrumentation developments*

### *In Europe:*

- *2004-2005: Feasibility of PEMS to check the conformity of heavy-duty engines*
- *2007 to 2008: Heavy-Duty PEMS Pilot program*
- *2011: PEMS based In-Service Conformity provisions for the HD EURO VI standards (Regulation 582/2011 also applicable for EURO V engines, amended by Regulation 64/2012\*)*
- *2010(-2012): Non-Road Mobile Machinery PEMS Pilot program*
- *2012: Working group on Real Driving Emissions of Light Duty Vehicles*

*\* Includes PEMS demonstration tests on prototype vehicles*



# Emission Standards

- *Main elements:*
  - *type approval*
  - *conformity of production*
  - *in-service tests*
  
- *Type approval: regulated pollutant emissions meet the applicable limits*
  
- *Conformity of production: ensures that all products of a type are in compliance with type approval specifications.*
  
- *In-service tests: ensure that the real products are compliant while they are in use during their normal life.*





## ***Assessing the in-use emissions performance:***

- ***In the laboratory, using conventional facilities (chassis dynamometer or engine test cell): spots checks can be conducted on cycles addressing specific situations or random cycles.***
- ***During the real-world operation with PEMS (in-use), provided that:***
  - 1. The experiments provide accurate data (Instrumentation)***
  - 2. The evaluation method has the ability to properly assess the emissions performance.***



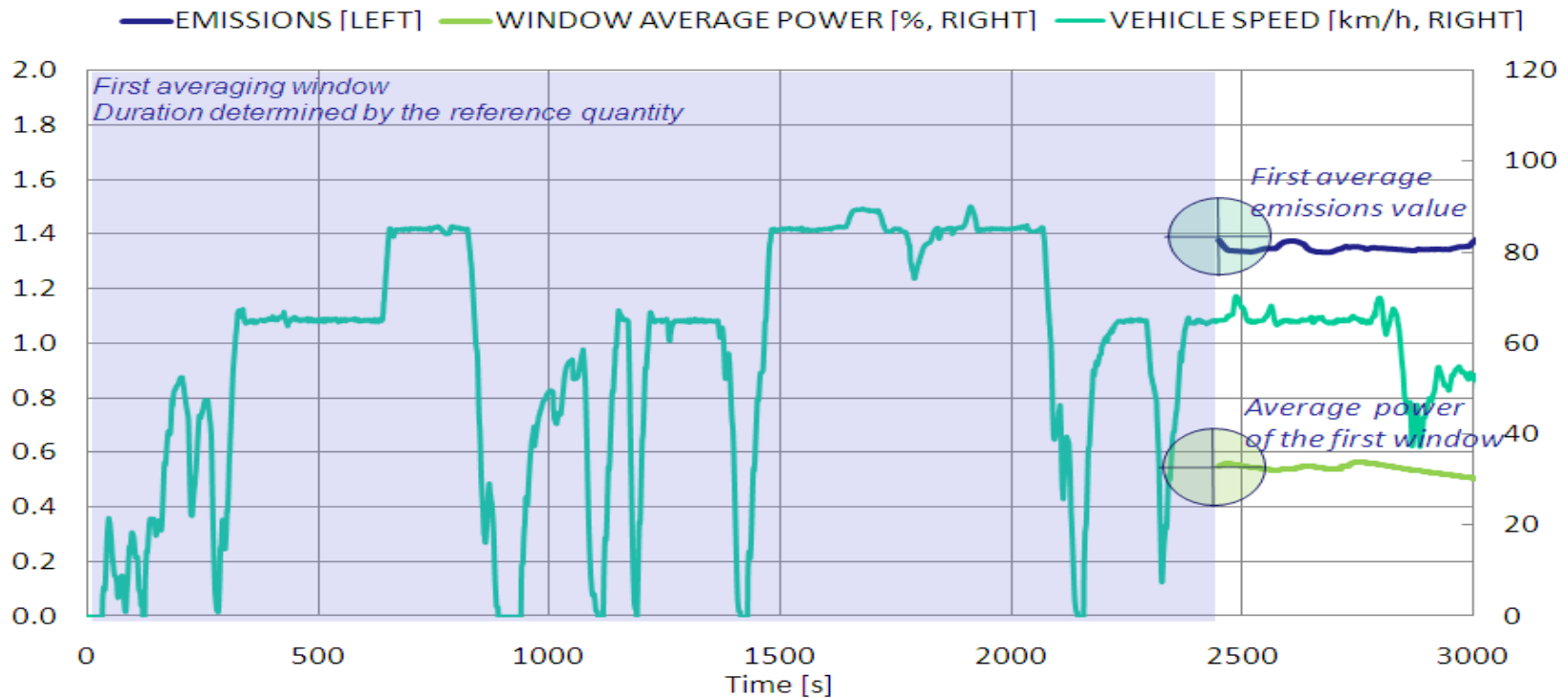


## Principles for In-Use (PEMS) Data Evaluation

- *Exclusion of data outside the applicable ambient and engine/vehicle conditions*
- *Averaging process (on sub-sets or 'windows')*
- *Operation areas (thresholds) on the averaged data set*
- *Not To Exceed principle (Within a given area, a percentage of the averaging window emissions cannot exceed a defined value)*

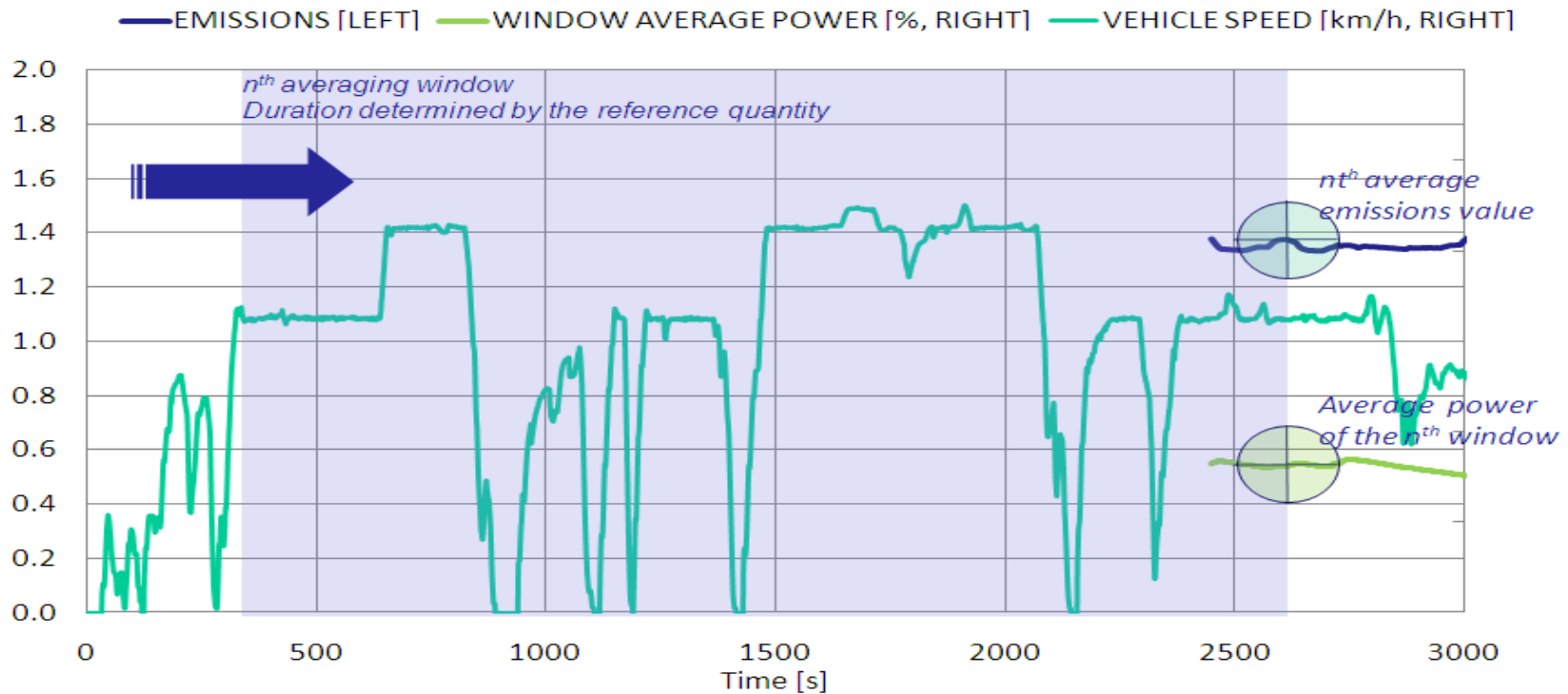


# HD ISC Engines Data Evaluation (1)

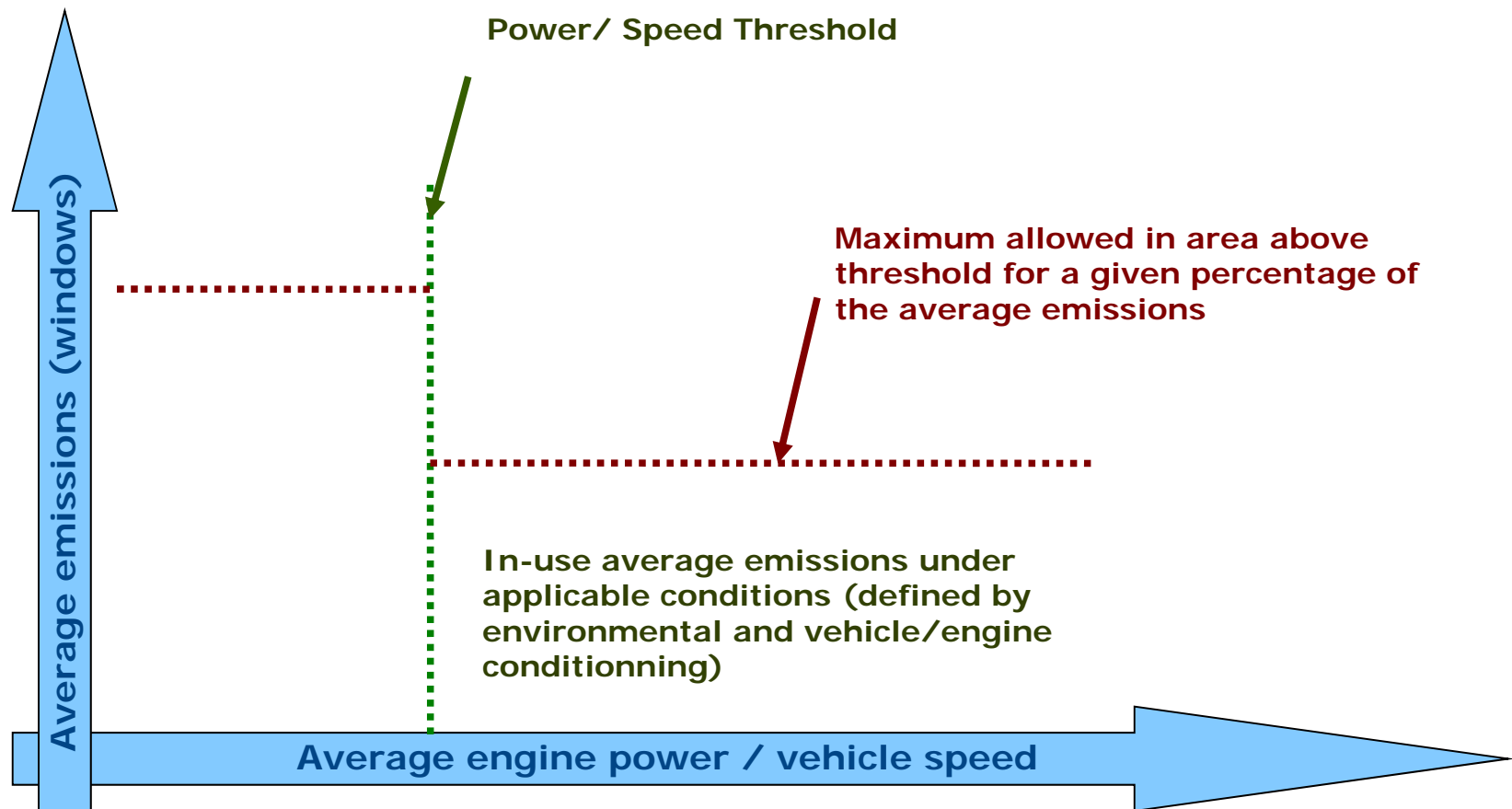




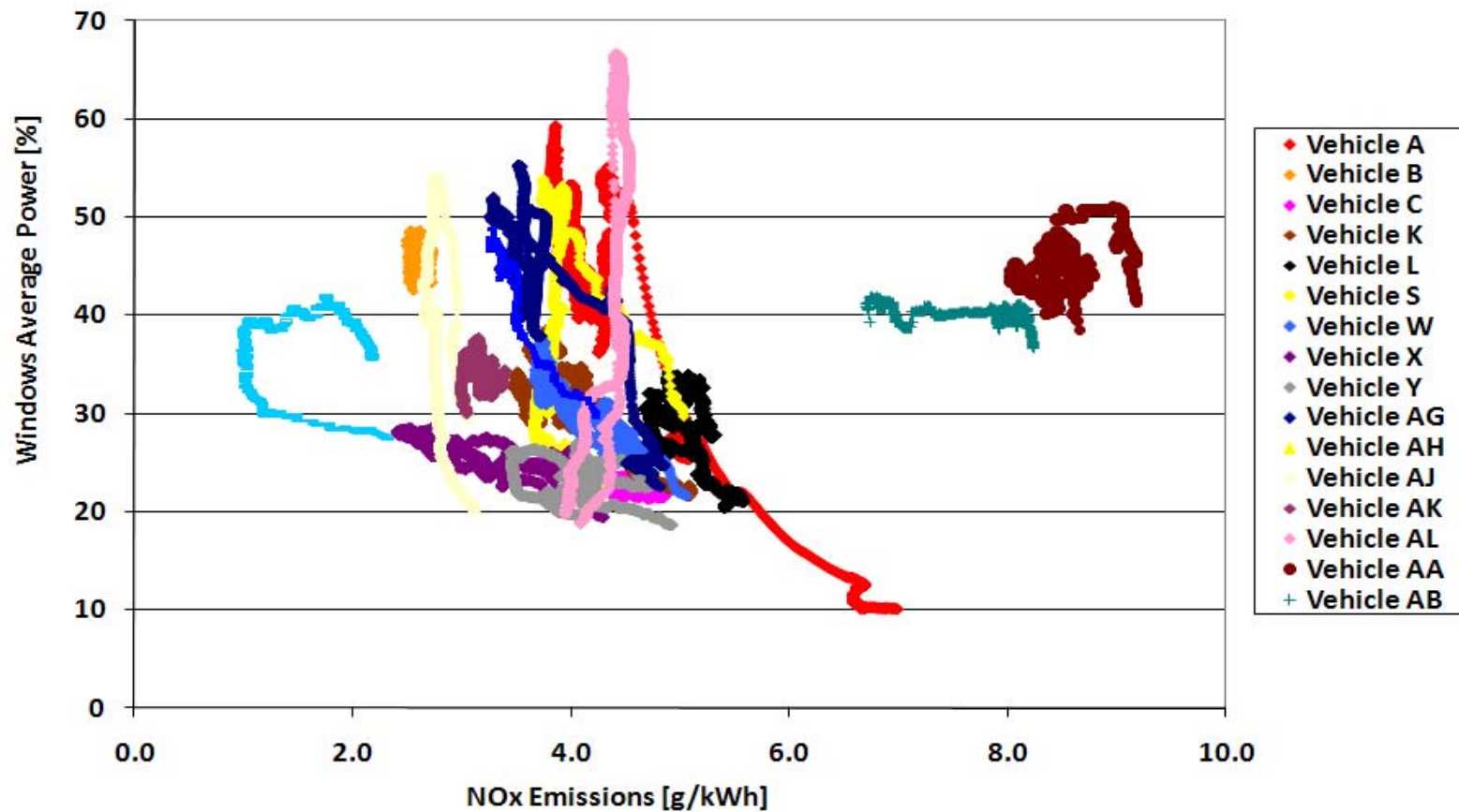
## HD Engines Data Evaluation (2)



# Principles for In-Use (PEMS) Data Evaluation



# EU Heavy-Duty PEMS Pilot Program





## *Heavy-Duty Engines In-Service Conformity (ISC) evaluation:*

- *Exclusion of data outside the applicable conditions*
  - Cold engine (based on coolant temperature)
  - Altitude (based on barometric pressure)
  - Ambient temperature
- *Moving Averaging Window*
  - Reference quantity: Engine Work or CO<sub>2</sub> mass emissions transient certification cycle
  - EURO V : European Transient Cycle (ETC)
  - EURO VI: World Harmonized Transient Cycle (WHTC)
- *Exclusions of windows below the power threshold*
  - 20% of the maximum engine power
  - If less than 50% of the windows are valid, the threshold is decreased by steps of 1%
- *90% the windows must have a conformity factor lower than or equal to 1.5*



## On-going developments: Heavy-Duty

- *Review of EURO VI ISC-PEMS procedures to be completed by end 2013*
- *Pilot program: Development of PM provisions, including the instrumentation requirements and the development of on-vehicle test protocol (organization phase, tentative launch summer/fall 2012)*
- *Adaptation of methods/rules to hybrids*





## On-going developments: Non-Road

- *Pilot Program until end 2012*
- *Implementation under discussion - Preparation of procedures for the Stage IV (entry in force 2014) and V standards*





## Potential developments

- *Control of LDV Real-Driving Emissions (EURO 6-2014)*
- *Validation of HDV CO<sub>2</sub> emissions for type approval*
- *Validation of HDV hybrid certification results (Hardware in the loop simulation, UN-ECE HILS )*
- *Standards harmonization (e.g. EU & US PEMS data evaluation rules)*





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## Analyzing on-road emissions of light-duty vehicles with Portable Emission Measurement Systems (PEMS)

Martin Weiss, Pierre Bonnel, Rudolf Hummel, Urbano Manfredi,  
Rinaldo Colombo, Gaston Lanappe, Philippe Le Lijour, Mirco Sculati



EUR 24697 EN - 2011



*The JRC in its role of technical support to the policies of the EU has published several reports on the use of PEMS as ISC and RDE tool for HDV, NRMM and LDV*







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## EU-PEMS PM EVALUATION PROGRAM - First Report

Bonnel, P., Carriero M., Forni F., Alessandrini S., Montigny F.,  
Demircioglu H., Giechaskiel B.



EUR 24543 EN – 2010

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## EU-PEMS PM EVALUATION PROGRAM - Second Report - Study on Post DPF PM/PN Emissions

A. Mamakos, M. Carriero, P. Bonnel, H. Demircioglu,  
S. Alessandrini, F. Forni, F. Montigny, D. Lesueur

EUR xxxxx EN - 20xx



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Analyzing on-road emissions of light-duty  
vehicles with Portable Emission  
Measurement Systems (PEMS)

Martin Weiss, Pierre  
Rinaldo Colombo, Ga



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HEAVY-DUTY ENGINES  
CONFORMITY TESTING BASED  
ON PEMS

Lessons Learned from the European Pilot Program

Pierre Bonnel

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EU-PEMS PM EVALUATION PROGRAM -  
Third Report – Further Study on Post DPF  
PM/PN Emissions

A. Manakos, M. Carriero, P. Bonnel,  
H. Demircioglu, K. Douglas  
S. Alessandrini, F. Forni, F. Montigny, D. Lesieur



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*Thank you for your attention*

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