

# Dutch Dual-Fuel Test Program

Information and Update

<http://www.rdw.nl/TGK/en/tgk/Pages/Dual-Fuel.aspx>

# Introduction

- Applications for conversion to dual-fuel
- No legal possibilities for type approval
- Dual-Fuel Test Programme
  - participation of stakeholders
  - gain experience
  - individual approvals
  - N2, N3, M2 and M3 (Euro I - V or EEV)



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# Dual-Fuel Test Programme

- system/documentation requirements
- safety inspection
- emission test
  - individual approval
- experiences and results can be used for the development of test procedures and regulation



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# Dual Fuel Test Program Test setup

Experience with three test setups:

- Engine test stand
- Simulation of ETC and ESC cycles on a vehicle/powertrain test stand
- Road data with PEMS

*All three setups were used in the Dutch Dual Fuel Test Program*

# Dual Fuel Test Program Test setup

Three test setups:

- Engine test stand:
  - OEM engine with ECU capable to run on an engine test bed. All vehicle functions switched off.
  - Engine dismantled from the Truck. The engine is connected to the vehicle. Wiring loom is extended. Complicated and time consuming procedure. Typical Test setup without support from OEM.
- Simulation ETC and ESC cycles on a vehicle/powertrain test stand. Driveline losses are taking in account and the gear ratio is fixed during the test. Correction of the losses are described in Dutch DF test program. For AMT (automated manual transmissions the idle speed is increased approx. 100 rpm to avoid opening the clutch in idle conditions.
- Road data with PEMS. Problem here is measuring the fuel consumption and particulates.

# Fuel

- Market fuel or reference fuel?

*Both types are allowed for the Dutch DF program*

- Fuel consumption measurement of the two fuels is required

# Emission Sampling

Issue is the fluctuating fuel composition

Matters to take in account:

- Fuel flow measurement of the two fuels is required
- Wet/dry correction of the emissions

# Test bench Results - CNG

- The engine exceeded the PM and NO<sub>x</sub> emission limits (100% diesel operation)
- Appr. 15% gas energy ratio in the ETC  
*(up to 40% diesel substitution claimed)*
- No GHG benefit due to CH<sub>4</sub> emission  
*4.8% CO<sub>2</sub> reduction offset by 1.5 g/kWh NMHC*  
*3.6% CO<sub>2</sub> reduction offset by 1.18 g/kWh CH<sub>4</sub>*
- Appr. 18% NO<sub>x</sub> reduction
- PM emission level remained equal

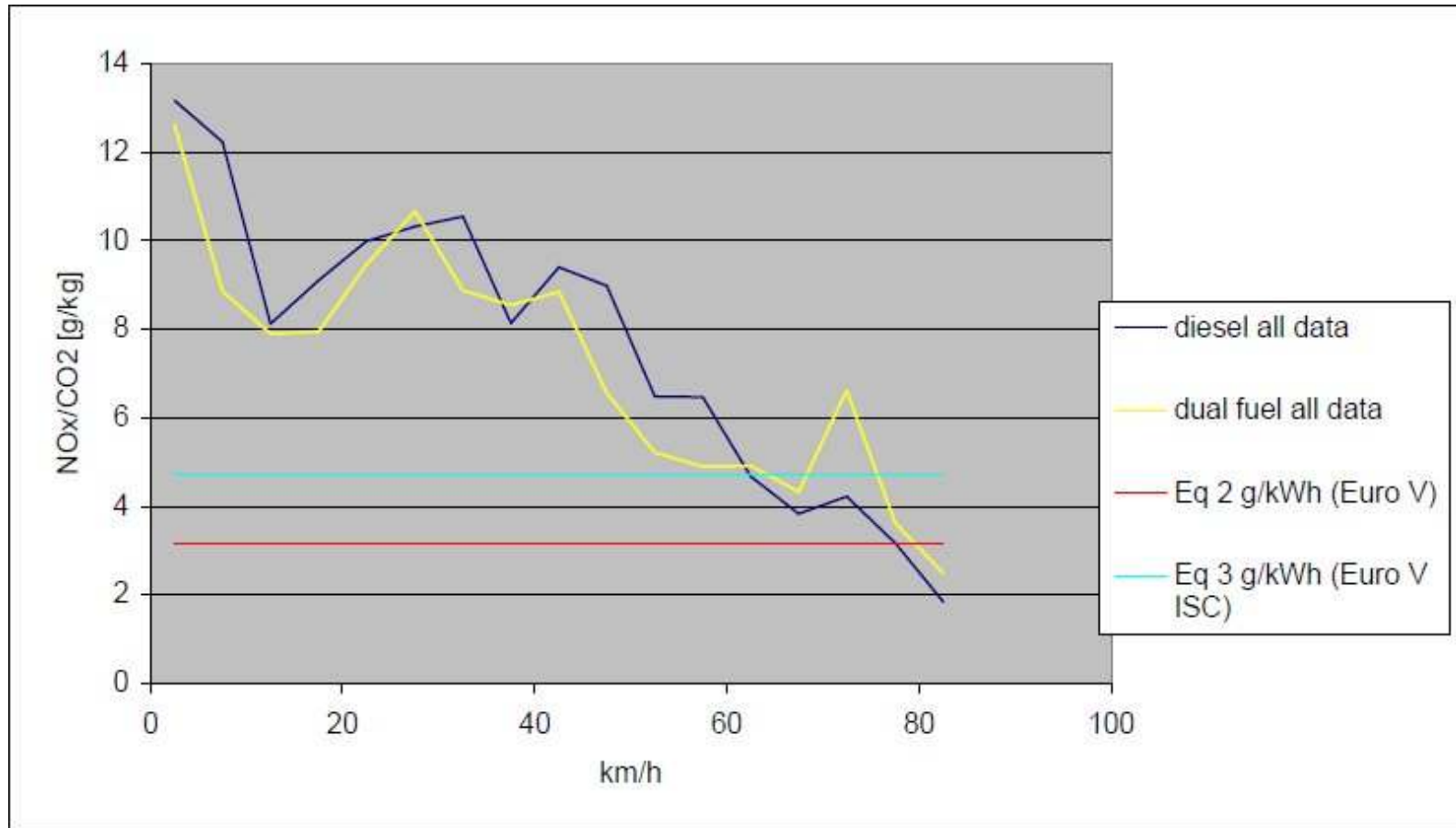


# Results

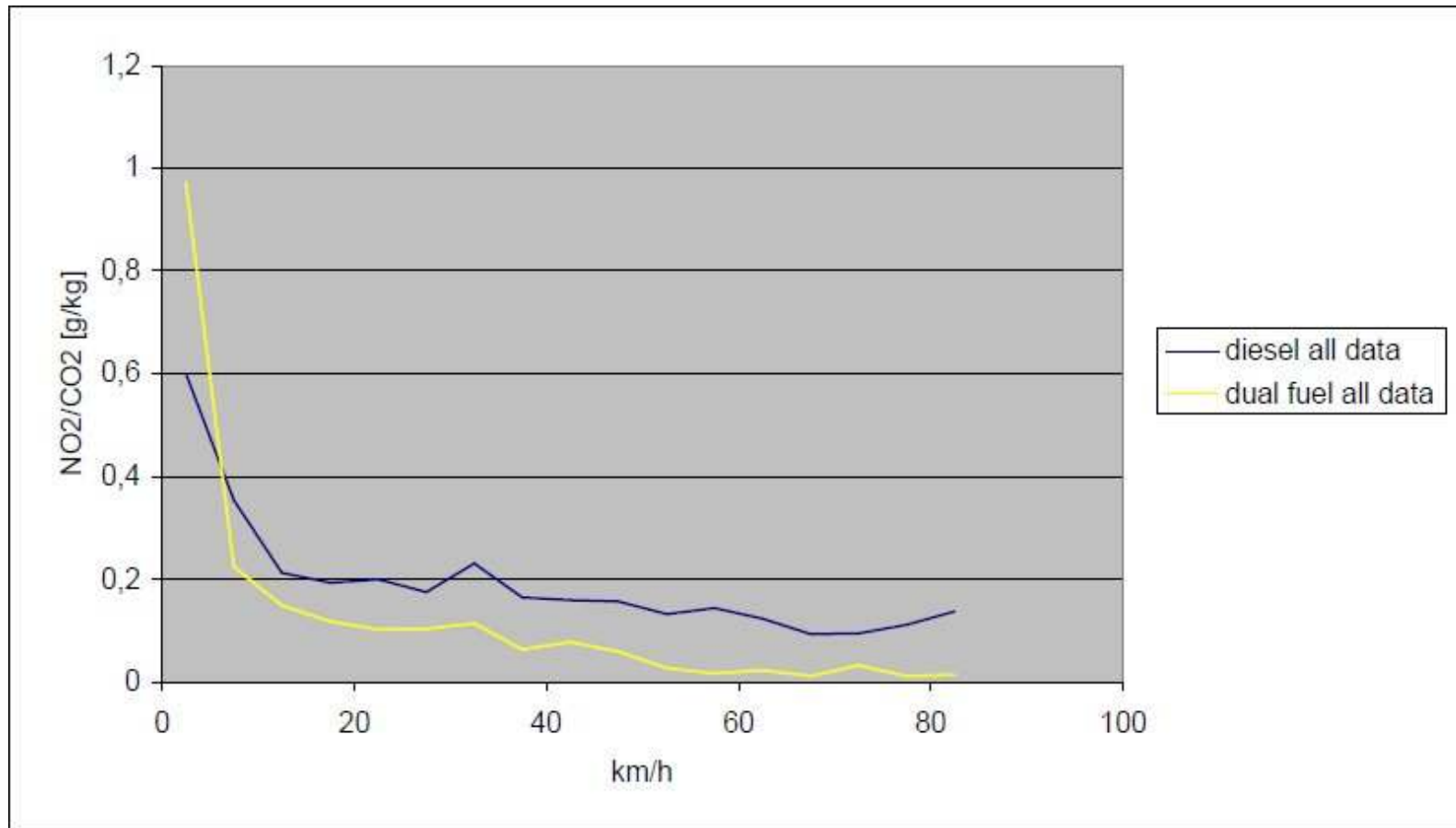
- Only type-2 engines/vehicles tested
- NO<sub>x</sub> emissions on diesel (too) high
- CNG HC emissions above the limit
- LPG HC emissions within limits
- No CO<sub>2</sub> benefit observed
- Difference between measured and claimed diesel replacement



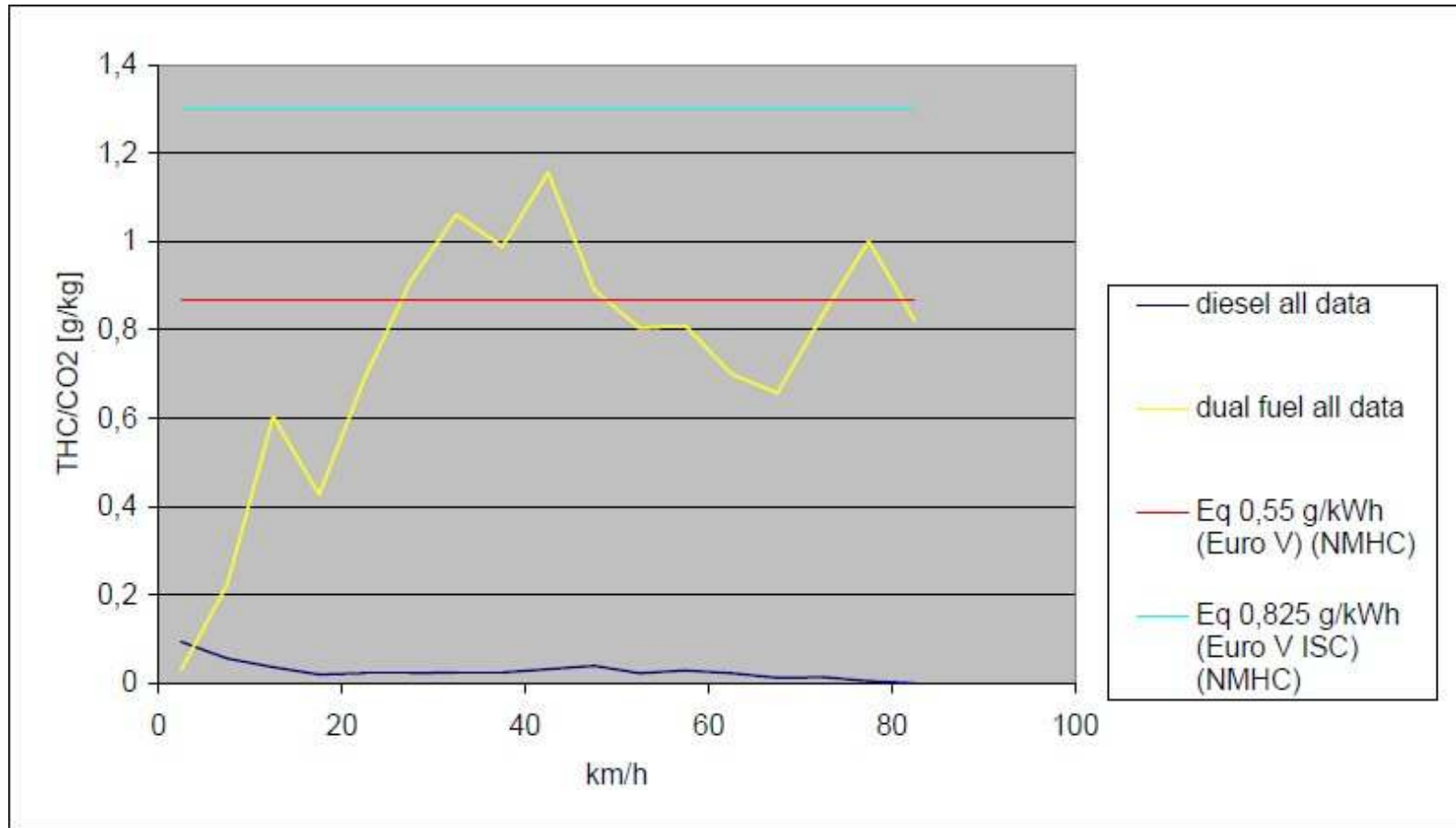
# PEMS



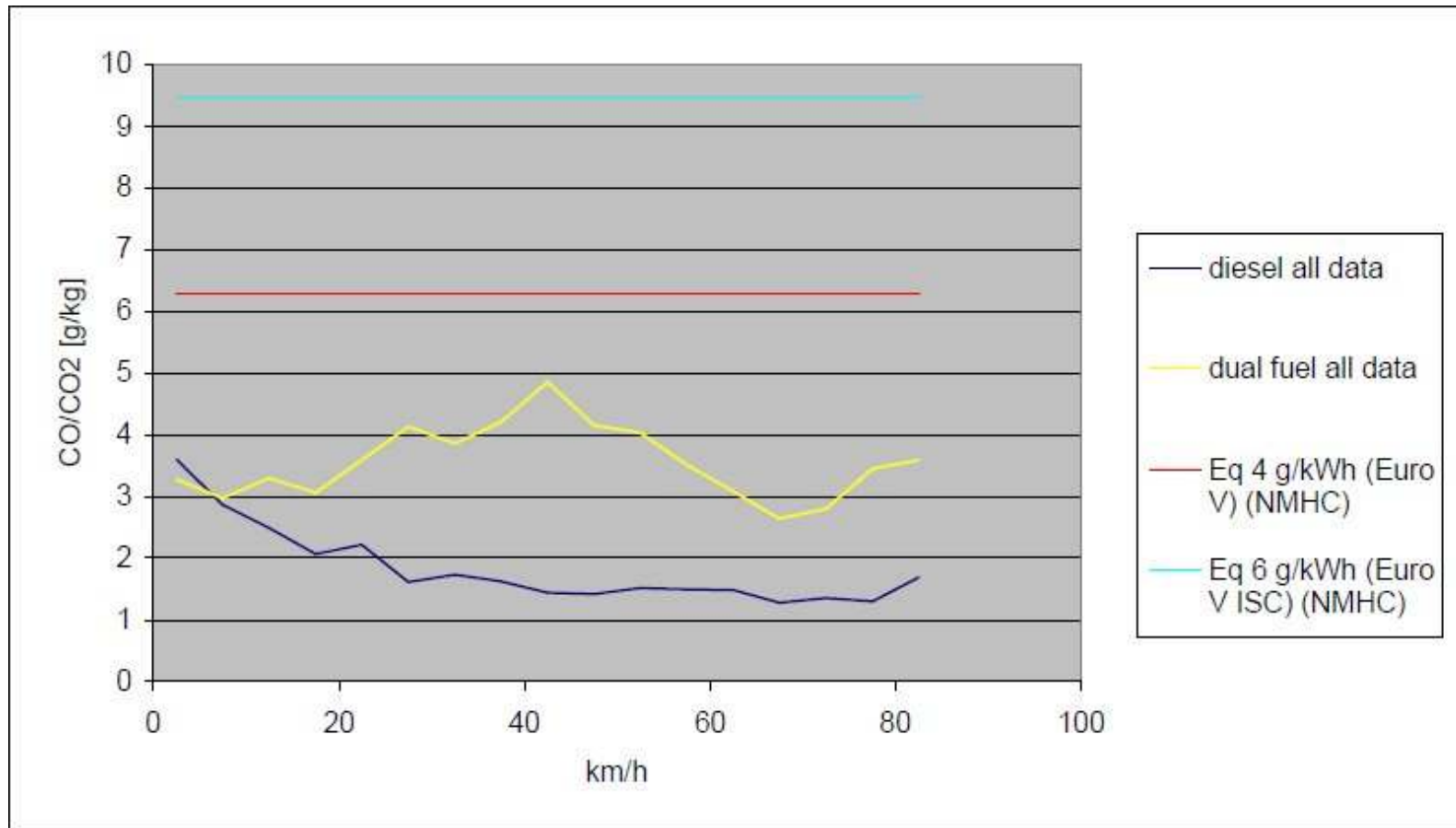
# PEMS



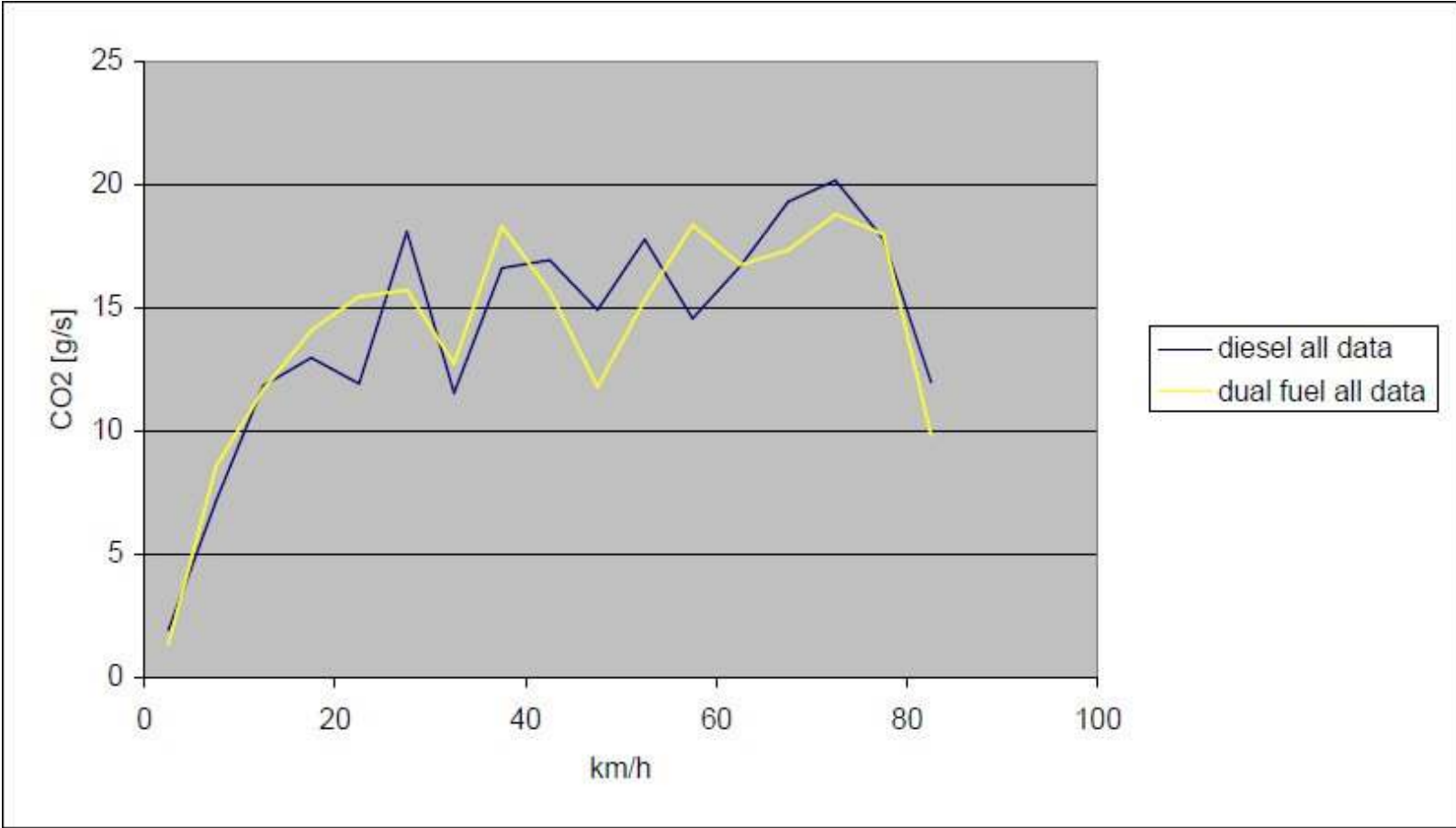
# PEMS



# PEMS



# PEMS



# Findings and issues

- Used vehicles have sometimes high mileage (400.000 kilometers). The diesel emission may be above the emission limit. How to handle in that case the dual fuel emission result?
- So far no OBD failures found while using dual fuel.
- Lifetime effects unknown.
- In use emission data is unknown. Also the effect of different ambient conditions (Humidity, Temperature, Altitude)
- Most data from engines with SCR technology. No EGR data.
- With DF technology it is possible to meet EURO V emission levels in the type approval cycles. Real life emissions are unknown. CH<sub>4</sub> problematic
- Family concept and choice of parent engine. What will be the effect on emissions at different power ratings in the same engine family.
- Test program in progress. National regulation under consideration.