European Commission

EURO 5 EFFECT STUDY FOR L-CATEGORY VEHICLES

UN L-EPPR
October 2016

emisia

Data Analysis and Consultancy

TNO innovation for life

LAT

PROJECT OUTLINE

- **Tender ID:**
  - Title: Euro 5 Effect study for L-category vehicles
  - Tender No: 465/PP/GRO/IMA/15/11825
  - Contract No: SI2.713570
  - Client: European Commission - DG-GROWTH

- **Consortium performing the work:**
  - TNO - The Netherlands
  - EMISIA - Greece
  - Laboratory of Applied Thermodynamics (LAT) - Greece
  - Heinz Steven Data Analysis and Consultancy (HSDAC) - Germany

MAIN REQUIREMENTS OF THE STUDY

- Perform an **experimental assessment and verification programme** to **underpin Euro 5 stage**.

- Assess the feasibility and cost-effectiveness of **possible post Euro 5 elements**:
  - **in-service conformity** testing requirements
  - **off-cycle emission** requirements
  - **Expand PM limit scope and introduction of a PN emission limit** for **certain (sub-)categories of L-category vehicles**.
  - A cost-benefit analysis is currently on going in these issues
- **This presentation contains the preliminary conclusions on the introduction of the Euro 5 limit in 2020**

DIFFERENT PHASES OF THE STUDY

Pre-Study	Experimental Test programme (JRC	Responsibility **JRC**
Effect Study Phase 1	Stocktaking and data mining Public Survey, Literature survey Planning Phase 2.-3	
Effect Study Phase 2	Experimental Test Programme Cost/benefit analysis, Impact assessment	Responsibility **Contractors** under JRC supervision
Effect Study Phase 3	Validation Programme, Report	

European Commission

EURO 5 LIMIT INTRODUCTION IN 2020

TECHNOLOGY AND ENVIRONMENTAL ASSESSMENT

EMISSION LIMITS (REGULATION (EU) 168/2013)

Euro 4

Vehicle category	Vehicle category name	Propulsion class	Euro level	Mass of carbon monoxide (CO)	Mass of total hydrocarbons (THC)	Mass of oxides of nitrogen (NO_x)	Mass of particulate matter (PM)	Test cycle
				L_1 (mg/km)	L_2 (mg/km)	L_3 (mg/km)	L_4 (mg/km)	
L1e-A	Powered cycle	PI/CI/Hybrid	Euro 4	560	100	70		ECE R47
L1e-B	Two-wheel moped	PI/CI/Hybrid	Euro 4	1 000	630	170	—	ECE R47
L2e	Three-wheel moped	PI/CI/Hybrid	Euro 4	1 900	730	170	—	ECE R47
L3e L4e ([7]) L5e-A L7e-A	— Two-wheel motorcycles with and without side-car — Tricycle — Heavy on-road quad	PI/PI Hybrid, v_{max} < 130 km/h	Euro 4	1 140	380	70	—	WMTC, stage 2
		PI/PI Hybrid, v_{max} ≥ 130 km/h	Euro 4	1 140	170	90	—	WMTC, stage 2
		CI/CI Hybrid	Euro 4	1 000	100	300	80 ([8])	WMTC, stage 2

Euro 5

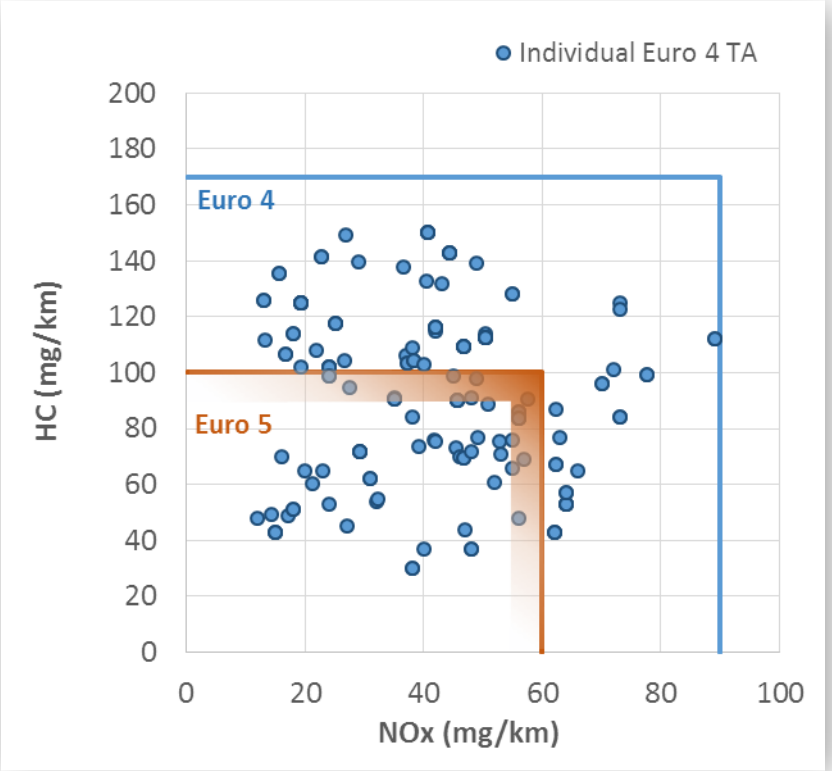
Vehicle category	Vehicle category name	Propulsion class	Euro Level ([4])	Mass of carbon monoxide (CO)	Mass of total hydro-carbons (THC)	Mass of Non-methane hydrocarbons (NMHC)	Mass of oxides of nitrogen (NO_x)	Mass of particulate matter (PM)	Test cycle
				L_1 (mg/km)	L_{2A} (mg/km)	L_{2B} (mg/km)	L_3 (mg/km)	L_4 (mg/km)	
L1e-A	Powered cycle	PI/CI/Hybrid	Euro 5	500	100	68	60	4,5 ([9])	Revised WMTC ([10])
L1e-B-L7e	All other L-category vehicles	PI/ PI Hybrid	Euro 5	1 000	100	68	60	4,5 ([9])	Revised WMTC
		CI/CI Hybrid		500	100	68	90	4,5	Revised WMTC

WHERE CURRENT TYPE APPROVAL VALUES STAND

Already ~40% of L3e TAs comply

Euro 5 numerical HC/NOx limits

CO compliance reaches 96%



Source: Sept. '16 Kraftfahrt-Bundesamt L3e Type Approval data

Note: Euro 5 limit uncertainty range due to 0.5/0.5 weighing factors

EXPECTED TECHNOLOGY NECESSITATED

- Motorcycles
  - Marginally larger catalyst and/or higher Platinum Group Metals (PGM) loading
  - Improved engine tuning for cold-start emission suppression
  - In some models: Closed-couple pre-cat + main catalyst or closer placement of main catalyst

- Mopeds
  - Elimination of two-stroke engines
  - Four-stroke engines with electronic fuel injection
  - Thermally optimized three-way catalyst for fast light-off

ENVIRONMENTAL ASSESSMENT
COST-BENEFIT ANALYSIS (CBA)

OVERVIEW OF CBA APPROACH

Fleet data
(new registrations and total stock based on national data)

Activity data
(annual mileage driven and total vehicle-kilometers based on national data)

Implementation date for Euro 5 & emission factors

Emission modelling using SIBYL fleet dynamics
(calculation of emission savings of Euro 5 over Euro 4)

Cost-effectiveness analysis
(cost per unit of mass of pollutants saved)

Cost-benefit analysis
(Euro 5 limits, durability, OBD, evaporation, ...)

COPERT Baseline emission Factors

Check and adjust with latest measurements at JRC, LAT, TNO

Assess future factors based on emission limits and technology development projections

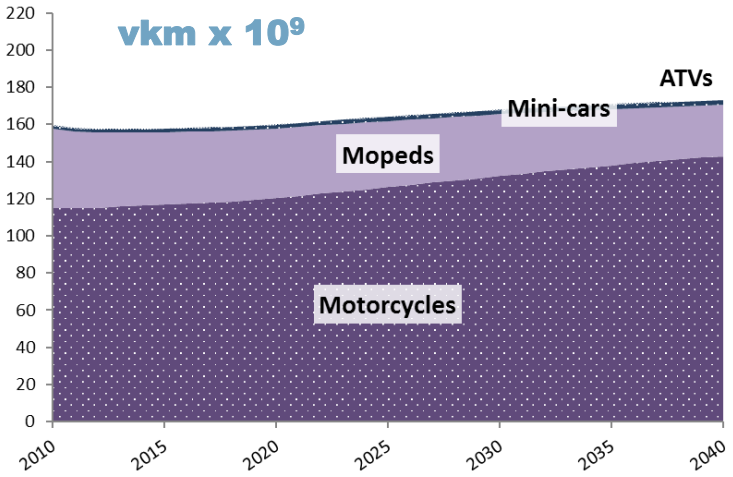
Technology assessment

Investment, H/W, TA, etc. costs

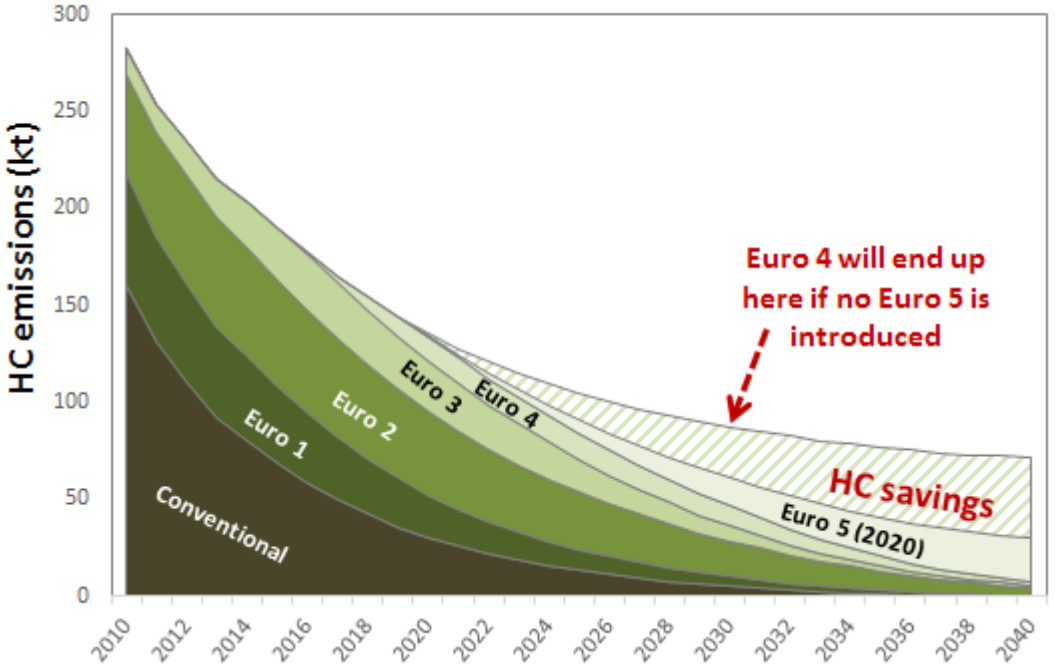
BASELINE SCENARIO FOR THE FLEET/ACTIVITY DATA

- **Motorcycles:** their contribution to activity dominates, mainly due to shrinkage of mopeds sector and higher mileage (annual distance driven)
- **Mopeds:** their contribution to activity presents a continuous decrease from 2010 to 2040
- **Mini-cars and ATVs:** Small overall contribution to total activity (but effects on local air quality)

- **'Business as usual' scenario after an initial sales rebound**
- **Consistent with statistical data for historical years, projections based on historical data and justified estimation of future trends**



HC EMISSIONS SAVINGS BY INTRODUCING EURO 5 LIMITS

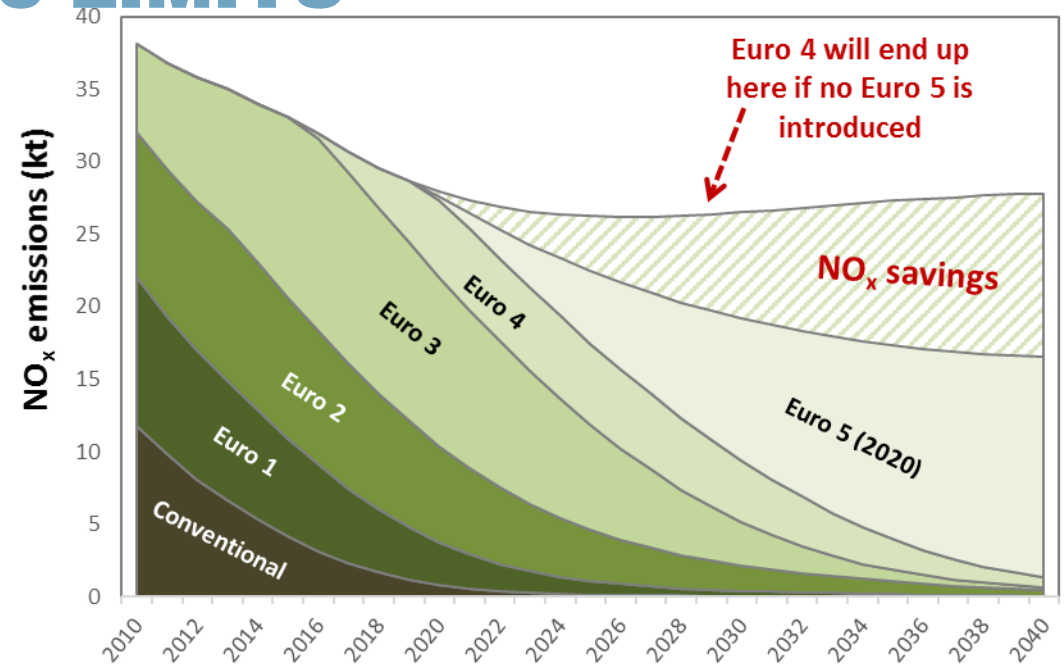


- **~509** kt HC can be saved when Euro 5 is introduced in 2020 for all L-vehicles
  - **~52%** emission savings over Euro 4

    2020-2040 period: HC savings / Euro 4 vehicle emissions = 509kt / 979kt = 52%
  - **~26%** emission savings of the whole L-category fleet emissions

    2020-2040 period: HC savings / total L-fleet emissions = 509kt / 1,950kt = 26%

NO_x EMISSIONS SAVINGS BY INTRODUCING EURO 5 LIMITS

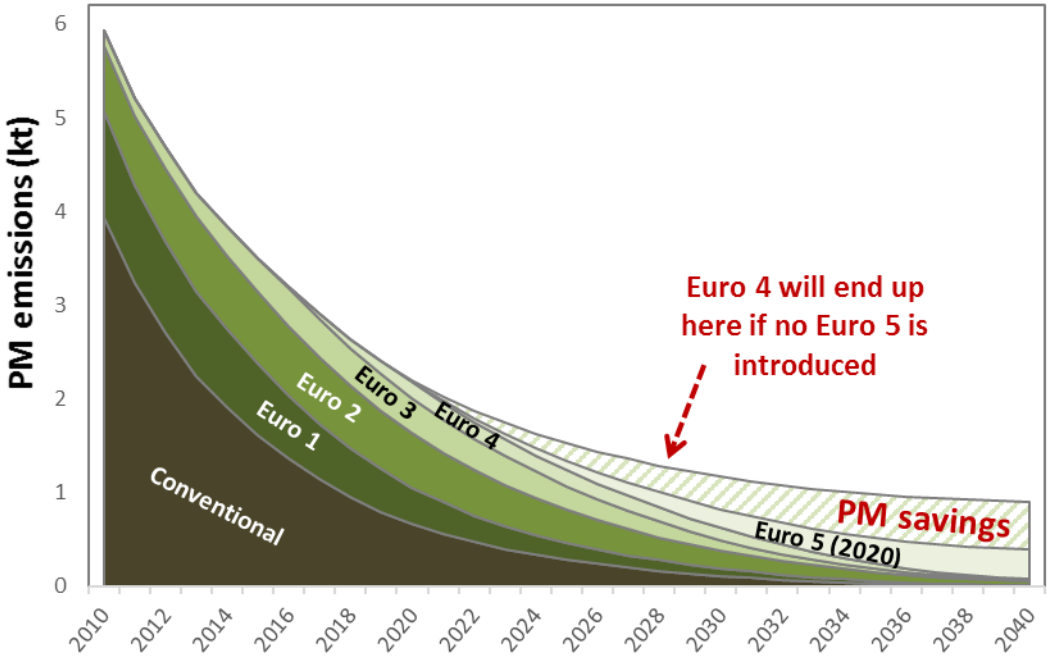


- **~141** kt NO_x can be saved when Euro 5 is introduced in 2020 for all L-vehicles
  - **~34.5%** emission savings over Euro 4

    2020-2040 period: NO_x savings / Euro 4 vehicle emissions = 141kt / 408.5kt = 34.5%
  - **~25%** emission savings of the whole L-category fleet emissions

    2020-2040 period: NO_x savings / total L-fleet emissions = 141kt / 566kt = 25%

PM EMISSION SAVINGS BY INTRODUCING EURO 5 LIMITS



- **~6.6** kt PM will be saved when Euro 5 is introduced in 2020 for all L-vehicles
  - **~51.5%** emission savings over Euro 4

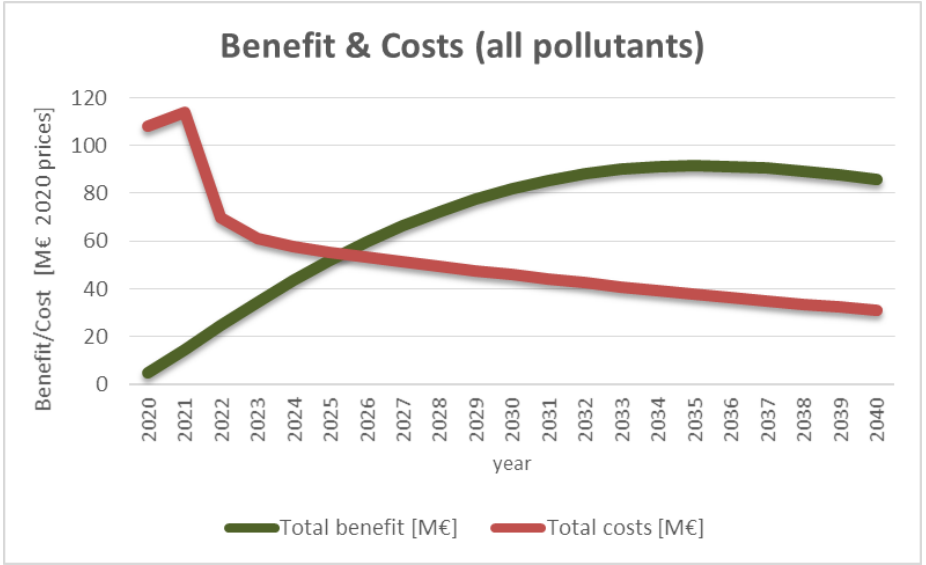
    2020-2040 period: PM savings / Euro 4 vehicle emissions = 6.6kt / 12.8kt = 51.5%
  - **~24%** emission savings of the whole L-category fleet emissions

    2020-2040 period: PM savings / total L-fleet emissions = 6.6kt / 27.3kt = 24%

COST BENEFIT ANALYSIS RESULTS

(Values in M€)	Cost-benefit over 2020-2040
Mopeds	89 ± 55
Motorcycles	114 ± 83

Euro 5 introduction in 2020



- Total costs of Euro 5 (not price!) per vehicle (2020-2040 period):
  - Mopeds: 83 to 93 €/vehicle
  - Motorcycles: 39 to 48 €/vehicle

PELIMENARY CONCLUSIONS

- Proposed Euro 5 emission limits are technically feasible to be reached by 2020
- New limits entail thermal optimization of currently available technology
  - Stoichiometric combustion and three way catalyst
- Cost-benefit analysis suggests societal benefits in monetary terms exceed associated costs over a 20-year assessment period ne
- Implementation costs are marginal for motorcycles and relatively more significant for mopeds

NEXT STEPS

- Oct 2016 – draft final report submitted to DG GROW
- Nov 2016 – present preliminary study results to industry specialists / stakeholders
- Dec 2016 – final report submitted to DG GROW
- Jan 2017 – presentation of the final report in European Parliament
- Jan 2017 – presentation of final results in UN L-EPPR
- April 2017 – presentation of final results in MCWG