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Phase 1 of the Environmental Effect Study on the Euro 5 step of L-category vehicles

Stocktaking and data mining

Michael Clairotte, Alessandro Zardini, Giorgio Martini

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Abstract

The European Union Regulation 168/2013 [1] requires an environmental effect study to confirm the provisions (defined therein and in Regulation 134/2014 [2]) for the type approval of the Euro 5 L-category vehicles (two- or three-wheel vehicles and quadricycles, such as quads and minicars). This effect study aims at providing additional information using modelling, technical feasibility and cost-effectiveness analysis based on the latest available data. Upon request of DG-GROW (Directorate General for Internal Market, Industry, Entrepreneurship and SMEs), the European Commission Joint Research Centre (JRC) undertook a pre-study [3] and the phase 1 of the effect study. The phase 1 includes the stocktaking of L-category vehicles and data mining of their type I test values (tailpipe emissions after a cold-start, prescribed driving cycle), which are presented in the present report.

From the stocktaking collected, it was found that very scarce data related to other L-categories than two-wheel moped (L1e) and motorcycle (L3e) are currently available. In addition, data originating from different sources (e.g., manufacturers and EUROSTAT) displayed noticeable differences in terms of vehicle stock (up to 8%) and new registration, in particular for L1e category. A source of harmonized stocktaking data are required to ensure reliable model projections, and guarantee unbiased cost-benefit analysis.

From the datamining on type I test values from L-category vehicles, the overview was achieved for actual L1e, L3e, powered tricycle (L5e) and heavy quadricycle (L7e) based on data collected from the German Federal Motor Transport Authority (KBA). It was found that L1e was the category displaying the highest share of models with type I test values lower than Euro 4 emission limits, followed by the L3e and the L5e categories (63%, 8%, and 7% respectively). In addition, the L3e and the L5e categories presented models already complying with Euro 5 standards. Finally, the L7e category displayed models complying neither with Euro 4, nor Euro 5 standards. Therefore, among the L-categories studied in this report, L7e may have to undertake a significant effort to comply with the foreseen Euro 4 and Euro 5 standard.

1. Introduction

1.1 Background

European Regulation (EU) No 168/2013 [1] (Reg. 168 thereon) on the approval and market surveillance of two- or three-wheel vehicles and quadricycles, supplemented with Regulation (EU) No 134/2014 [2] (Reg. 134 thereon), introduces the L-category family of vehicles which includes mopeds, motorcycles, quads and minicars (see Table 1). The Regulations outline harmonized rules for the type approval of L-category vehicles in two steps. Euro 4 (new vehicle types in 2016) and Euro 5 (2020) steps for L-category vehicles assist in improving (urban) air quality by reducing the share of pollutant emissions emitted by L-category vehicles.

The 2009 impact assessment conducted prior to the adoption of Reg. 168 concluded that mopeds and light motorcycles emit disproportionately high hydrocarbon (HC) levels compared to other modes of road transport (e.g. cars, trucks and buses) [4]. However, that impact assessment considered only the application of the Euro 4 step to L-category vehicles. The Euro 5 environmental step contains a package of measures designed to reduce particulate matter (PM) and ozone (O_3) precursors such as nitrogen oxides (NO_x) and HC.

Based on future available data, the Reg. 168 requires an environmental effects study to provide additional information using modelling, technical feasibility and cost-effectiveness analysis based on the latest available data. In addition, the study should, inter alia, assess the feasibility and cost-effectiveness of in-service conformity testing requirements, off-cycle emission requirements and a particulate number emission limit for certain (sub-) categories.

On the basis of the effect study results, the European Commission (EC) might present a proposal to the European Parliament introducing new elements into future type-approval legislation.

On behalf on Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW) the EC Joint Research Centre (JRC) was assigned the task to undertake:

1- Pre-study: scientific research to define a common engine load variable and associated experimental test programme [3],

2- Phase Ia: **stocktaking of L-category vehicles and data mining of their type I test values**,

3- Phase Ib: stakeholder survey [5].

As part of Phase I, stocktaking of representative data among vehicles currently placed on the EU market was achieved based on data available between September 2014 and June 2015. In addition, recent and currently available type I test values (i.e. tailpipe emissions after a cold start of the vehicle engine) related to L-category vehicles were collected and analysed. This report summarizes the main findings of these two elements.

1.2 Structure of the report

This report presents the latest information available regarding stocktaking in the member countries of the European Union (EU28) as well as current data related to type I test values of L-category vehicles. In addition to this introductory section, the report is structured as follows:

- Section 2 presents the methodology followed to explore stocktaking and type I test values data.

- Section 3 presents the main findings obtained from the exploratory analysis carry out on the stocktaking and type I test values data.

- Section 4 lists the main conclusions of this study.

Table 1: L-category vehicles classification according Reg. 168 - Annex I.

L1e		**L2e**	**L3e**	**L4e**	**L5**		**L6e**		**L7e**		
Light two-wheeled vehicle		***Three-wheel moped***	***Motorcycle***	***With side car***	***Tricycle***		***Light quadricycle***		***Heavy quadricycle***		
L1e-A *Powered cycles*	**L1e-B** *Moped*	**L2e**	**L3e**	**L4e**	**L5e-A** *Tricycle*	**L5e-B** *Commercial tricycle*	**L6e-A** *Light quad*	**L6e-B** *Light quadrimobile*	**L7e-A** *Heavy on-road quad*	**L7e-B** *Heavy all terrain quad*	**L7e-C** *Heavy Quadmobile*
		L2e-P 	L3e-A1 	L4e-A1 				L6Be-P 	L7e-A1 	L7e-B1 	L7e-CU 
	Limited speed 	L2e-U 	L3e-A2 	L4e-A2				L6Be-U 	L7e-A2 	L7e-B2 	L7e-CP 
			L3e-A3 								
≤50cc, ≤25 km/h, 250W--1kW	≤50cc, ≤45 km/h, <4 kW	≤50cc, ≤45 km/h, <4 kW, ≤270 kg	<= 11 kW, A2: <=35 kW		3W, <1000 kg,	3W, <1000 kg, max 2 seats, V 0.6m^3	<4kW, ≤425 kg, ≤45 km/h (D, G)	<6kW, <425 kg, ≤45 km/h (D, G)	<15kW, ≤450 kg	W/G<6, ≤450 kg	P: ≤450 kg, U: ≤600 kg, (D, G)

2. Methodology

2.1 Stocktaking of L-category vehicles placed on the EU

Stocktaking of L-category vehicles is essential as it conditions the quality of further impact assessment analyses, and particularly the uncertainty linked to these analyses. Stocktaking information related to the L-category circulating park and new registration was collected from three sources:

- **ACEM website**
  A first document "*Powered two wheeler registrations in EU and EFTA countries 2014 statistical release*" (Feb. 2015) provides new registration of motorcycles and mopeds up to 2014 [6]. A second document "*European powered two wheeler market statistics*" (Mar. 2014) provides the latest figures, currently available, on the circulating park of motorcycle and mopeds up to 2012 [7].

- **DIONE fleet impact model**
  This fleet-impact assessment tool aims at testing the impact of changes in policies, vehicle technology, or fuel quality, on energy consumption, as well as on pollutant emissions (e.g. greenhouse gases, particulate matter) in EU28. DIONE historical data from the 2000-2009 period were extracted from the TRACCS project [8]. For the years following 2010, ACEM new registrations were used in the model. For this study, new registration and circulating park of mopeds and motorcycles (classified in 3 sub-categories by engine displacement) were extracted from DIONE, using PRIME 2012 baseline scenario for the stock development projection.

- **EUROSTAT website**
  EUROSTAT database contains figures related to mopeds and motorcycle circulating park up to 2012. In addition, Eurostat database provides new registration of motorcycle only, up to 2012. The website was accessed on the 06/05/2015, and the data collected were updated on the 02/03/2015.

Data from these three sources are partitioned by EU country and were compared in order to assess the level of agreement.

2.2 Data mining of type I test values related to L-category vehicles

Information related to type approval from L-category vehicles were collected from the German Federal Motor Transport Authority (Kraftahrt- Bundesamt KBA). In compliance with EC Directive 2003/4/EC, the KBA publishes regularly these values to insure public access to information linked to environmental matters [9]. Two databases were obtained from the KBA, representing the state of play of regulated emissions in 2009 and 2014 [10,11]. These databases provided CO_2 emission, fuel consumption and emission type test values for new vehicles with general operating licence or EC type approval sold in the German market. Please note that the KBA provides type approval data, not emission values from in-use vehicles. For an overview of emissions from in-use L-category vehicles refer to Adam et al. [12], Clairotte et al. [13], Zardini et al. [14], Platt et al. [15], and references therein.

In terms of fleet detail, 2009 and 2014 KBA databases included L-category vehicles broken down by different categories. In order to compare test values of models tested in 2009 with those tested in 2014, matching was achieved based on the model characteristics (i.e. engine displacement, engine power, max speed) as described in

Table **2**. Thus, a five-year trend (from 2009 to 2014) was estimated for L1e and L3e categories. Categories defined in Reg. 168, and used to discriminate fleet models in 2014 database, were followed to describe the type I test values in this study.

Table 2: Matching of 2009 and 2014 KBA databases by category.

2009 KBA database					**2014 KBA database**
Categories	Number of models	Range of engine capacity in cm^3	Range of engine power in kW	Range of max. speed in km/h	Equivalent categories acc. Reg. 168
Light-weight motor-assisted bicycle	1	30	1	20	L1e
Motor-assisted bicycle	27	30-50	1-3	20-30	L1e
Moped	4	49-50	2	45	L1e
Small motorcycle	311	48-50	1-5	25-45	L1e
Lightweight motorcycle	350	49-125	2-11	60-120	L3e
Motorcycle	1188	118-8215	3-304	70-312	L3e
Three and four-wheeled motor vehicle	218	49-1775	1-136	30-210	Not used*

* *Insufficient information was available to identify which sub-category the vehicles were belonging to, according to Reg. 168; consequently this category was not used.*

Type I test values obtained in the 2014 database were analysed through size-frequency histograms together with cumulative percent curves. For each regulated pollutant, namely HC, NO_x and carbon monoxide (CO), the purpose was to highlight the current status of the L-category subgroup regarding the foreseen Euro 4 and Euro 5 emission standards. The durability requirements included in Reg. 168 were taken into account for this assessment. Thus, type I test value were multiplied by the deterioration factors (DF), as defined in Article 23 of Reg. 168 (cf. mathematical durability procedure), prior comparison with the foreseen Euro 4 and Euro 5 standards. Table 3 shows the CO, HC and NO_x emission standards as well as the deterioration factors for Euro 4 and Euro 5 according Reg. 168. However, this assessment was not fully possible in the case of L1e category for which type I test values of HC and NO_x were cumulated until Euro 3 step. These pollutants will be regulated separately as from Euro 4.

Table 3: Euro 4 and Euro 5 Tailpipe emission limits after cold start and deterioration factors (indicated in parentheses) proposed in Reg. 168 for CO HC and NO_x. PI and CI stand for positive ignition and compressed ignition engine, respectively. Please note that Euro 4 and Euro 5 will include also non-methane hydrocarbons (NMHC) and PM emission limits.

Vehicle Category		**Propulsion class**	**Mass of CO in mg/km**		**Mass of HC in mg/km**		**Mass of NO_x in mg/km**	
			Euro 4	**Euro 5**	**Euro 4**	**Euro 5**	**Euro 4**	**Euro 5**
L1e-A	**Powered cycle**	PI/PI Hybrid	560 (1.3)	500 (1.3)	100 (1.2)	100 (1.3)	70 (1.2)	60 (1.3)
		CI/CI Hybrid				100 (1.1)		60 (1.1)
L1e-B	**Two-wheel moped**	PI/PI Hybrid	1000 (1.3)	1000 (1.3)	630 (1.2)	100 (1.3)	170 (1.2)	60 (1.3)
		CI/CI Hybrid		500 (1.3)		100 (1.1)		90 (1.1)
L2e	**Three-wheel moped**	PI/PI Hybrid	1900 (1.3)	1000 (1.3)	730 (1.2)	100 (1.3)	170 (1.2)	60 (1.3)
		CI/CI Hybrid		500 (1.3)		100 (1.1)		90 (1.1)
L3e L4e L5e-A L7e-A	**Two-wheel motorcycles with and without side-car, Tricycle and Heavy on-road quad**	PI/PI Hybrid, v_{max} < 130 km/h	1140 (1.3)	1000 (1.3)	380 (1.2)	100 (1.3)	70 (1.2)	60 (1.3)
		PI/PI Hybrid, v_{max} ≥ 130 km/h			170 (1.2)		90 (1.2)	
		CI/CI Hybrid	1000 (1.3)	500 (1.3)	100 (1.2)	100 (1.1)	300 (1.2)	90 (1.1)
L5e-B	**Commercial tricycle**	PI/PI Hybrid	2000 (1.3)	1000 (1.3)	550 (1.2)	100 (1.3)	250 (1.2)	60 (1.3)
		CI/CI Hybrid	1000 (1.3)	500 (1.3)	100 (1.2)	100 (1.1)	550 (1.2)	90 (1.1)
L6e-A L6e-B	**Light quadricycle**	PI/PI Hybrid	1900 (1.3)	1000 (1.3)	730 (1.2)	100 (1.3)	170 (1.2)	60 (1.3)
		CI/CI Hybrid	1000 (1.3)	500 (1.3)	100 (1.2)	100 (1.1)	550 (1.2)	90 (1.1)
L7e-B L7e-C	**Heavy all terrain quad Heavy quadrimobile**	PI/PI Hybrid	2000 (1.3)	1000 (1.3)	550 (1.2)	100 (1.3)	250 (1.2)	60 (1.3)
		CI/CI Hybrid	1000 (1.3)	500 (1.3)	100 (1.2)	100 (1.1)	550 (1.2)	90 (1.1)

Finally, top sales models of L-category vehicles in EU28 between 2012 and 2014 were identified, when possible, in the KBA 2014 database in order to give insight to their contributions in their respective category (data provided by the ACEM [16]).

KBA databases contain information related to manufacturer's brand; however, this information is not disclosed in this study. The scope is to provide an overview of type I test values related to current L-category vehicles sold in EU, regardless of the manufacturer's brand which is not disclosed in the present study.

3. Results

3.1 Stocktaking of current L-category vehicles in EU market

3.1.1 Global trend in EU28

The circulating park and new registration of mopeds and motorcycles obtained from EUROSTAT, ACEM and DIONE sources are displayed in Figure 1. As regards L-category circulating park in EU28 (top panels), moped and motorcycle data from EUROSTAT appeared to be lower than those of ACEM and DIONE. Until 2012, motorcycle stocks available from ACEM and DIONE were in good agreement. However, moped stocks from these two sources diverged, with ACEM data slightly lower than DIONE data. For the years preceding 2010 (period including DIONE historical data), ACEM and DIONE moped stocks were broadly stable, but with an offset of plus 2 million of vehicles for DIONE data (12.6 M and 14.6 M from ACEM and DIONE, respectively in 2009). Since then, moped stock from ACEM steadily decreased with an annual average of -2.6% while moped stock from DIONE steadily increased with an annual average of 2.3% on a yearly basis (2009-2012 period). Consequently, a difference of more than 3 million of L-category total stock appeared in 2012 between ACEM and DIONE data, mostly due to this moped stock discrepancy.

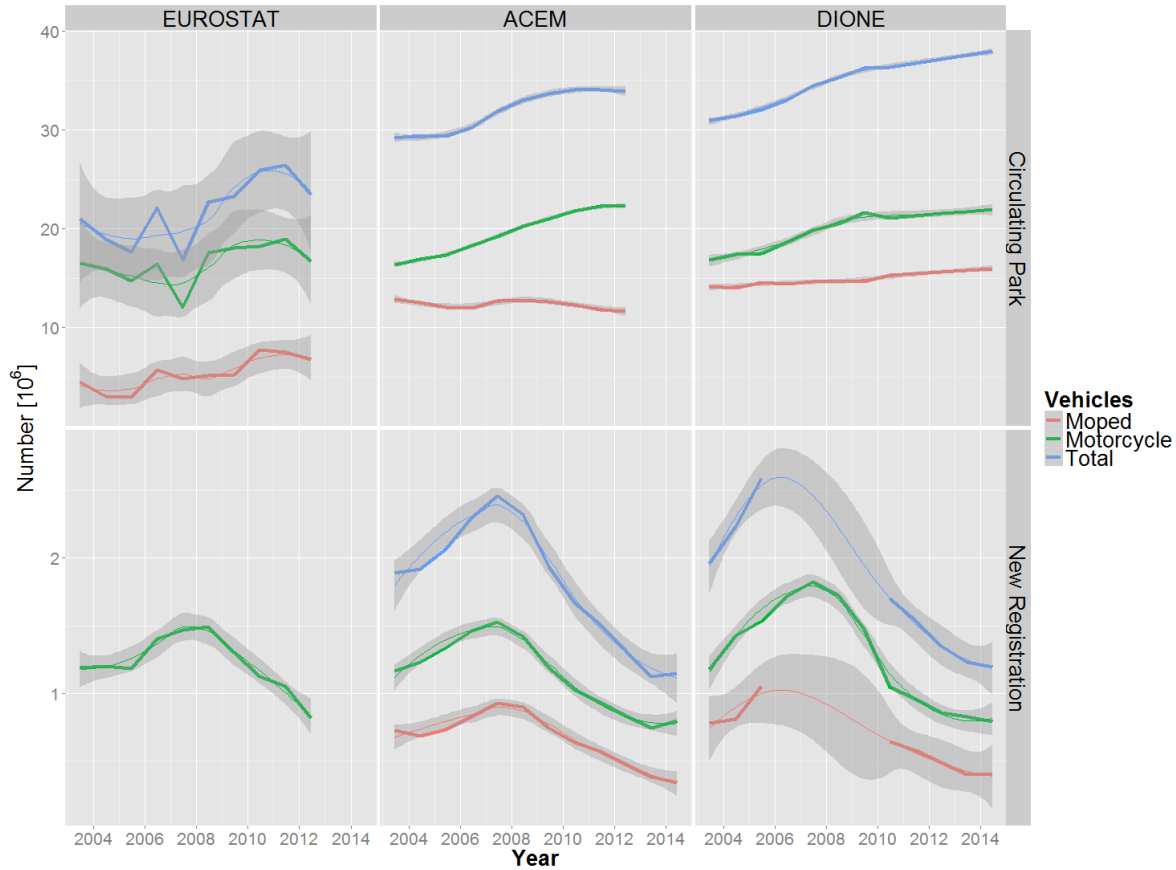

Figure 1: Circulating park (top) and new registration (bottom) of mopeds and motorcycles in EU28 by source of data.

This finding highlighted the difficulty to estimate moped stock in the future years, and consequently, to assess what would be the impact of the Reg. 168 on the amount of exhaust emissions. This is especially true considering the relative high contribution of mopeds in the L-category emissions, in particular for PM and HC. In the latest report delivering input to environmental study in support of the Euro 5 legislation of L-category vehicles, the significance of reducing emissions was estimated assuming a constant decrease of 1.2% of moped stock through 2030 [17]. This assumption could lead to an underestimation of the effect expected from the enforcement of the new Euro 4 and Euro 5 standards. The robustness of these findings might be investigated in the light of the latest contribution from DIONE.

L-category new registrations in EU28 are presented in Figure 1 (bottom panels). EUROSTAT, which did not provide moped new registration, displayed motorcycle new registration in good agreement with ACEM data. However, motorcycle new registration from DIONE during the period 2004-2011 were greater than ACEM and EUROSTAT data, with a maximum difference of 0.3 million of vehicles registered in 2008. Regarding moped new registration, ACEM and DIONE data were in very good agreement within the period 2010-2012, with an approximate decreasing trend of -9% on a yearly basis. However, starting from 2013, the size of the fall reached -15% on a yearly basis for ACEM data while moped new registration remained identical for DIONE data.

3.1.2 Trend per EU28 country

The total circulating park of L-category vehicles in the EU28 countries is presented in Figure 2 (2014 data from DIONE source). In 2014, four countries, namely Italy, Spain, Germany and France, accounted for 2/3 of the total L-category circulating park. In addition, these four countries registered 3/5 of new vehicles in EU28.

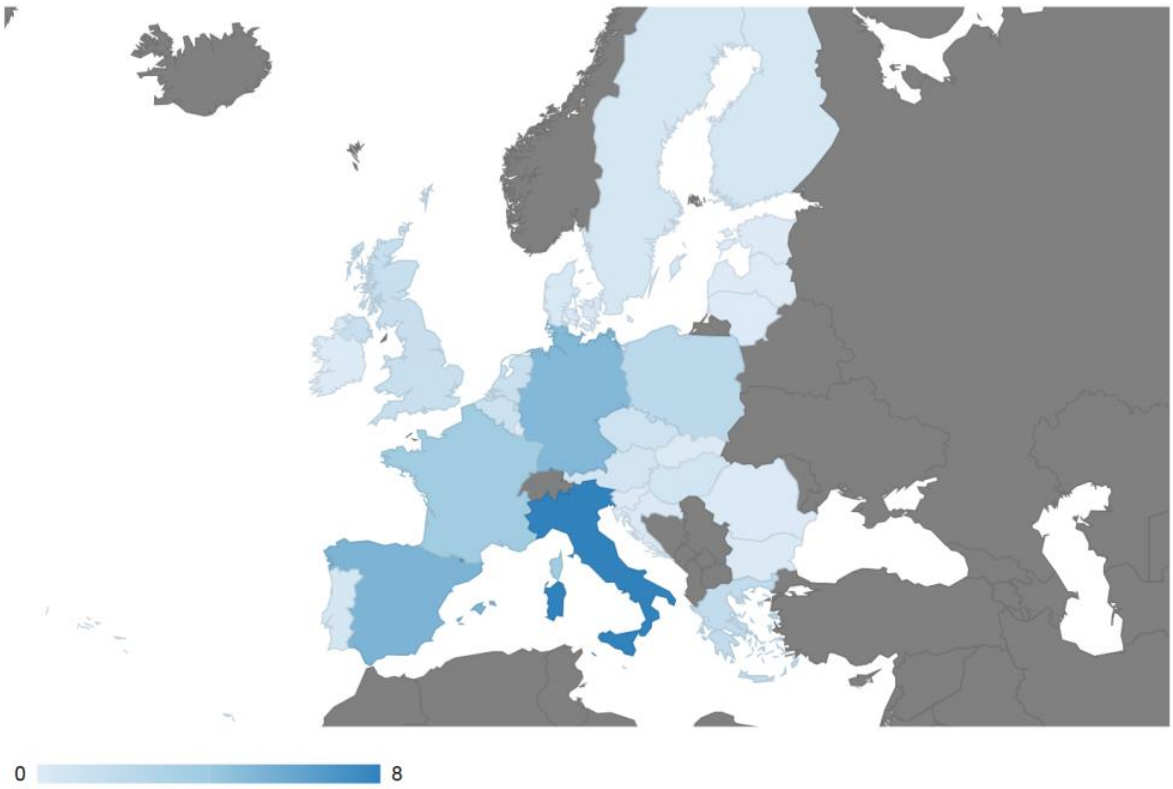

Figure 2: Circulating park of mopeds and motorcycles by EU28 country in 2014 (legend scale in millions of vehicle).

The Figure 3 shows these key European markets by circulating park (area of the rectangles) and new registration (colours of the rectangles) based on DIONE source. In terms of total new registration, the top five countries in 2014 were France, Italy, Germany, Spain and United Kingdom. The ranking was similar with regard to motorcycle new registration, with the inversion of the two first countries (with more than 156,000 motorcycles sold in 2014, Italy appeared first in the ranking). However, the picture was slightly different for the moped new registration, with a ranking of the top five countries composed of France, Netherlands, Poland, Germany and Italy (source ACEM).

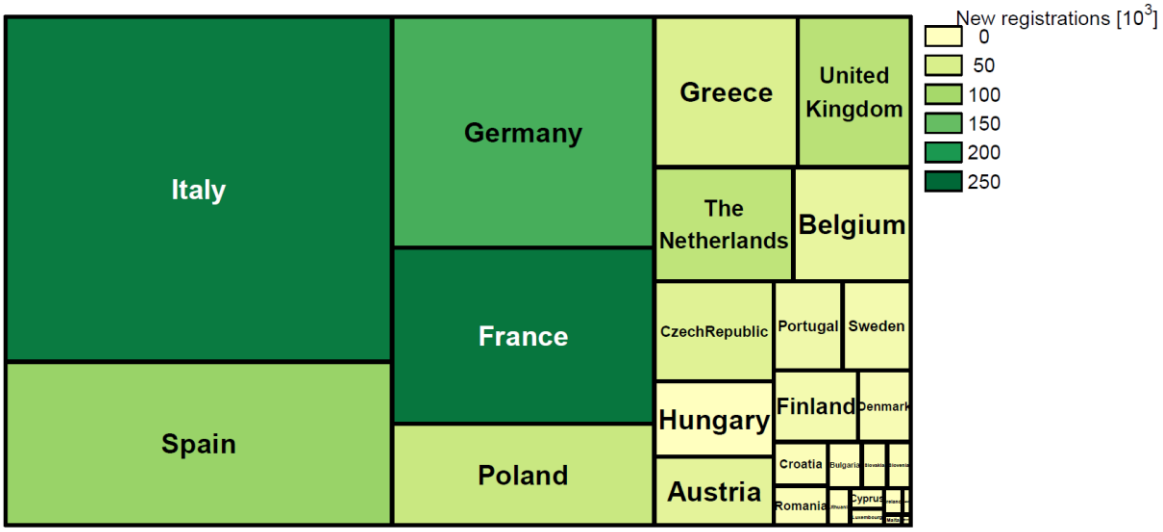

Figure 3: L-category European markets in EU28. Rectangle area refers to the circulating park while the colour refers to the new registration figures of mopeds and motorcycles.

Based on ACEM source, the 5-year trends of new registration for the seven largest European markets identified previously (France, Germany, Italy, Poland, Spain, United Kingdom and The Netherlands) are presented in Figure 4. Firstly, as observed in Figure 1, overall moped new registration decreased significantly over the EU key markets. The largest decrease occurred in Italy with more than 68% reduction between 2010 and 2014, which consisted in almost 62,000 fewer mopeds sold. It is worth noticing that The Netherlands, which is the second largest market for mopeds, showed sign of recovery with 6% more vehicles sold between 2013 and 2014. Considering moped new registration in 2014 based on DIONE source, this sign of recovery appeared also in Poland and Italy. However, these projected values have to be confirmed by the national authorities (e.g. "Automobile Club d'Italia").
Secondly, motorcycle new registration trend was more complex with three countries displaying more vehicles sold in 2014 compared to 2010 (Germany, Poland and United Kingdom), while the four other countries were displaying decrease in the same period. Like for moped new registration, the largest decrease occurred in Italy with roughly 50% reduction between 2010 and 2014, which consisted in almost 150,000 fewer motorcycles sold. However, the trend between the two last year 2013-2014 indicated a rebound in the seven largest European markets, with an average of 13% increase. Considering motorcycle new registration in 2014 based on DIONE source, this rebound did not appeared in United Kingdom and France.

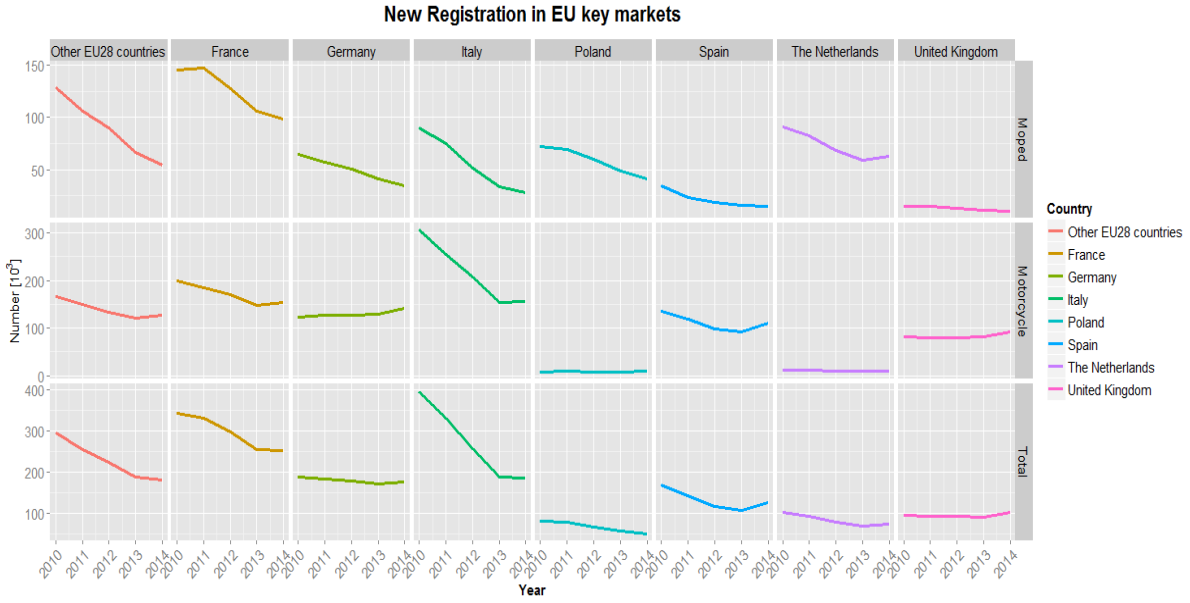

Figure 4: New registration of moped and motorcycle in the EU28 key markets based on ACEM source.

Figure 5 displays the composition of moped and motorcycle sales among the seven largest European markets above mentioned. As regards moped new registration, the picture of main markets changed between 2010 and 2014. Italy share was decreasing while France and The Netherlands shares were increasing during the same period. The same occurred for motorcycle new registration with Italy share decreasing while Germany and United Kingdom shares were increasing during the same period.

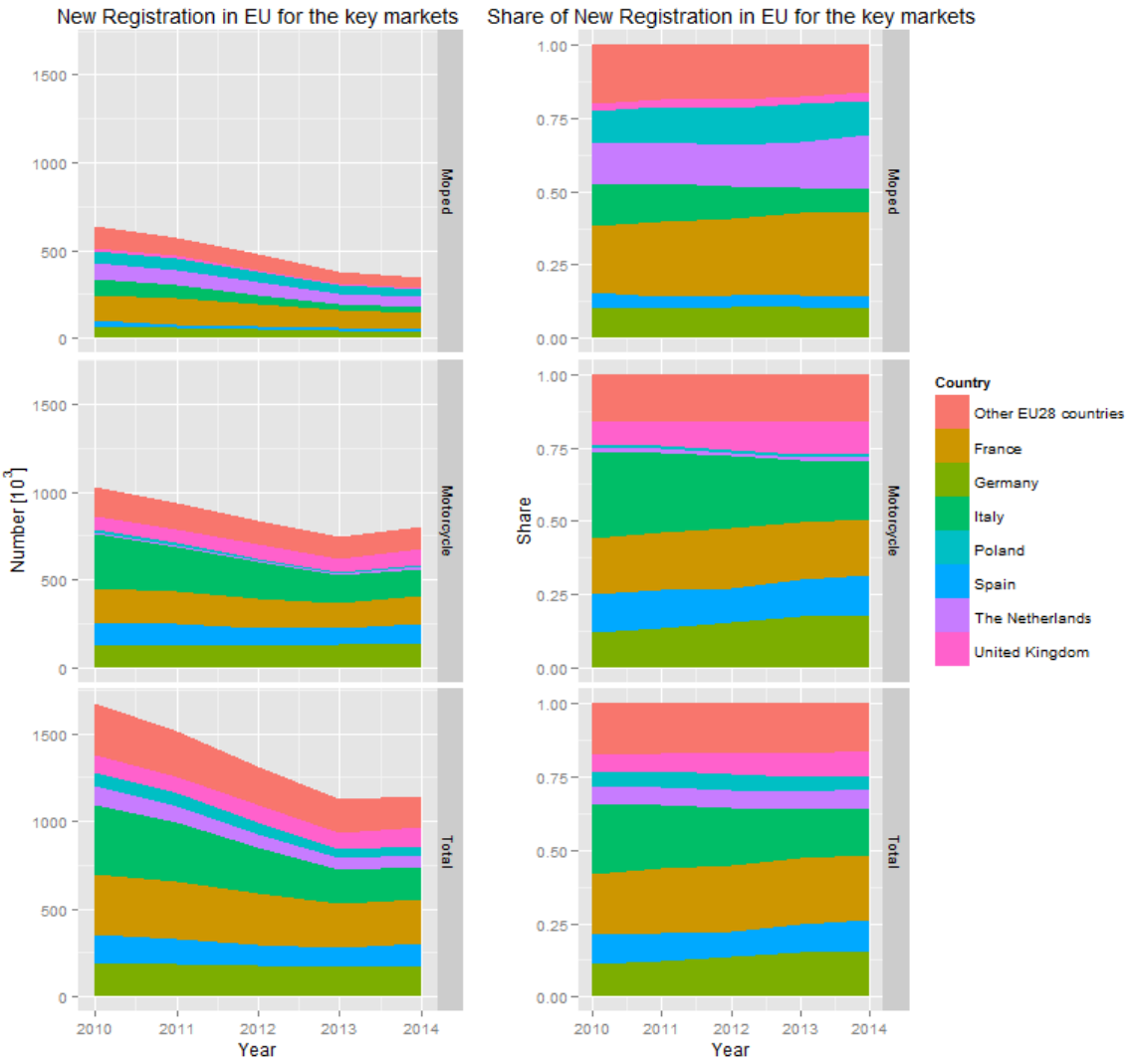

Figure 5: New registration of moped and motorcycle in the EU28 key markets based on ACEM source.

3.1.3 Conclusions on stocktaking of L-category vehicles

Stocktaking of L-category vehicle was carried out for L1e and L3e categories (mopeds and motorcycles) as insufficient data related to other L-sub-categories are currently available. This study highlighted the discrepancy in terms of vehicle stock and new registration between the different sources collected, in particular for moped category. These different figures, in addition to uncertainties linked to the projection made, could lead to substantial discrepancies when performing cost-benefit studies. In order to support impact assessment of future measures applied to L-category vehicles, it appears of the most importance to gather data from different sources (including vehicle manufacturers). These data should cover all L-category and should be harmonized based on the best knowledge available. Updated and reliable data may be useful to improve baseline projection used in DIONE model, in order to guarantee robust impact assessment associated to the adoption of Reg. 168.

3.2 Type I test values of current L-category vehicles in EU

Type I test values provided by the 2014 KBA database (described previously in section 2.2) were analysed by category (i.e. L1e – L7e), and by pollutant (CO, THC, NO_x, and THC+NO_x for L1e category). The Table 4 summarizes the number of models included in the database and the breakdown into transmission and propulsion class share. No L4e model was included in the KBA databases; therefore, this vehicle category (two-wheel motorcycle with side-car) will not be treated here.

Figure 6 depicts the statistical distribution of the power and engine capacity by category. The bottom and top of the box are the first and third quartiles respectively. The band inside the box is the median. The lower (and higher) whisker extends from the bottom (the top) of the box to the lowest (the highest) value that is within 1.5 times the inter-quartile range (distance between the first and third quartiles). Data beyond the end of the whiskers are outliers and plotted as points.

Table 4: Summary of the L-category models included in the 2014 KBA database.

Vehicle Category	Number of models	Number after removal of duplicate models*	Transmission share (Manual/Automatic**/not specified)	Propulsion class share (PI/CI/Electric/PI hybrid)
L1e	538	257	53/164/40	200/0/57/0
L2e	5	4	1/0/3	1/0/3/0
L3e	4961	1742	86/50/1606	1729/1/10/2
L4e	0	-	-	-
L5e	108	48	4/2/42	41/4/2/1
L6e	59	4	0/4/0	2/0/2/0
L7e	190	107	8/3/96	101/3/3/0

* *Duplicate means same manufacturer, same motor type, same type I test value (for CO, and THC+NO_x) in the 2014 KBA database.*

** *Automatic stands for automatic, variable and automatic mechanical transmission.*

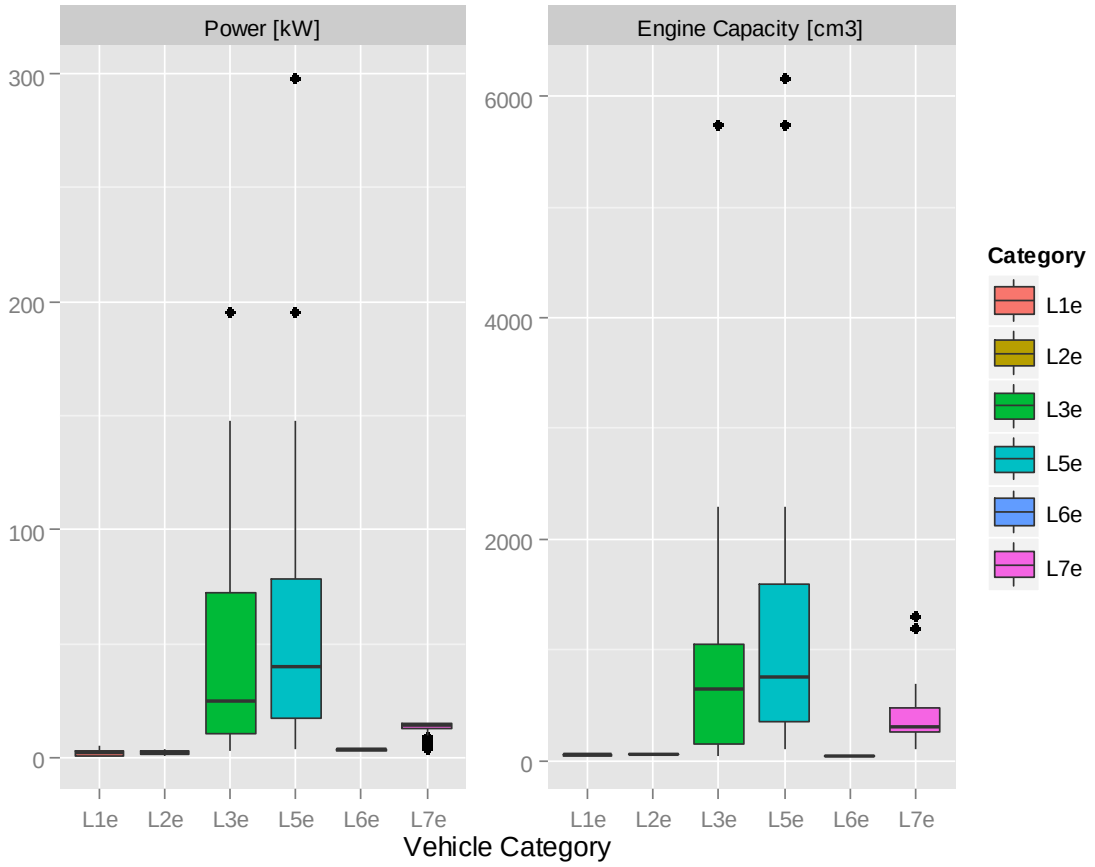

Figure 6: Descriptive statistics of the power and engine capacity of the L-category vehicles included in the 2014 KBA database after removal of the duplicate models.

3.2.1 Light two-wheel powered vehicle (L1e category)

The 2014 KBA database did not distinguish the L1e-A and L1e-B sub-categories. It was assumed that most of the models included in the database were L1e-B models, consequently the type I test values were compared to the expected Euro 4/5 limits for L1e-B sub-category.

3.2.1.1 Regulated emissions

CO emissions

Figure 7 displays the size-frequency histogram (top) and the cumulative percent curves distribution (bottom) of CO type I test values for the 200 L1e PI models. Considering Euro 4/5 limits of 1 g/km and 0.77 g/km including DF (1.3), 89% (178) of the L1e models had CO type I test values below Euro 4/5 limits including DF.

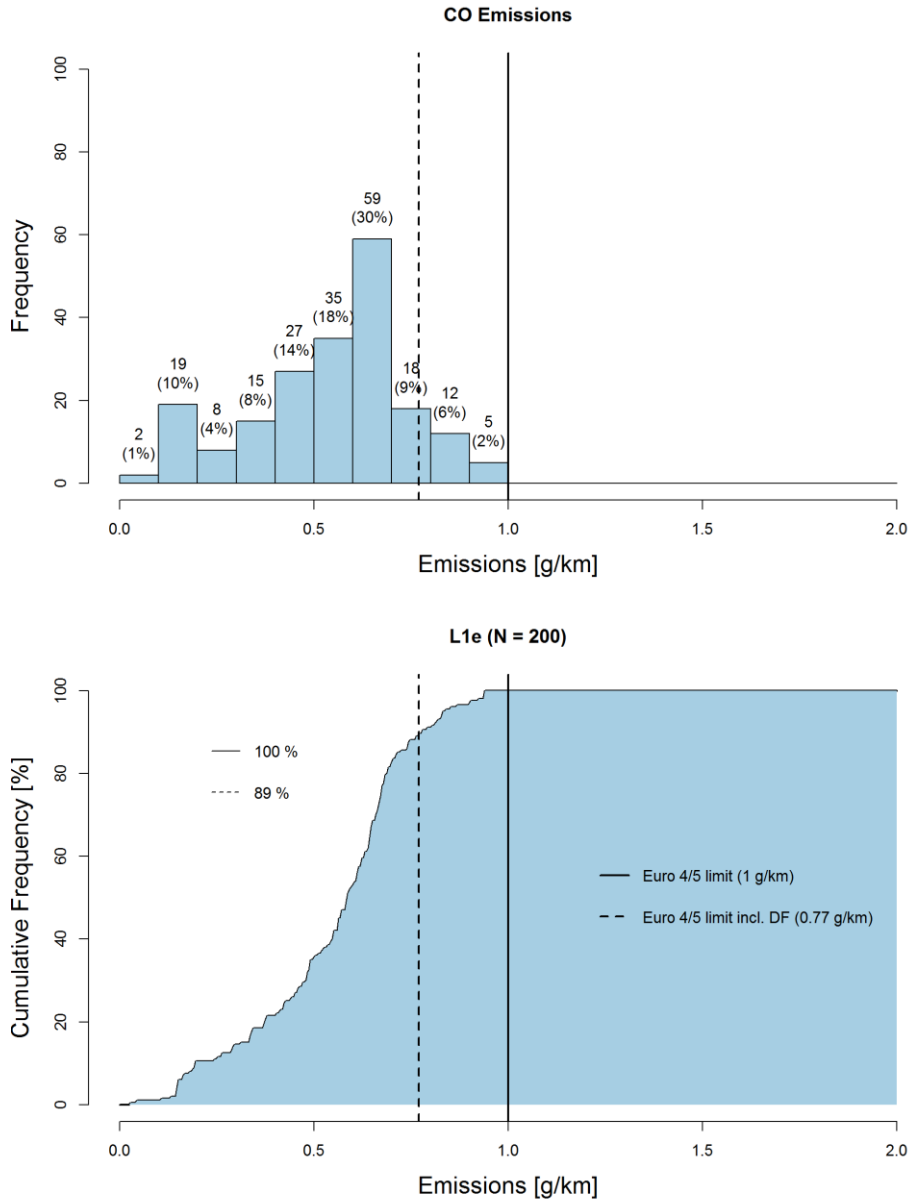

Figure 7: Size-frequency histogram (top) and cumulative percent curves (bottom) of CO type I test values for L1e PI models.

THC and NO_x emissions

Current European legislation related to two-wheel vehicles with engine displacement below 50 cm^3 (L1e category – Light two-wheel powered vehicle) establishes a combined emission standard for HC and NO_x [18]. However, the proposed emission standards for Euro 4 and Euro 5 are separated for these two pollutants. As a proxy, current state of play was assessed by comparing (THC+NO_x) type I test values from the 2014 KBA database to the sum of Euro 4/5 limits for THC and NO_x. L1e category did not include CI engine (see Table 4). Consequently, the Euro 5 limit for NO_x used was 0.06 g/km. Figure 8 displays the size-frequency histogram and the cumulative percent curves distribution of THC+NO_x type I test values for the 200 L1e PI models. Considering Euro 4 limits of 0.8 g/km and 0.67 g/km including DF (1.2), 68% (136) of the L1e models had THC+NO_x type I test values below Euro 4 THC and NO_x added limits including DF. Considering Euro 5 limits of 0.16 g/km and 0.12 g/km including DF (1.3), no available L1e model had

THC+NO_x type I test value below Euro 5 limits including DF. If the DF was not taken into account, 2% (4) of the L1e models had THC+NO_x type I test values below Euro 5 THC and NO_x added limits.

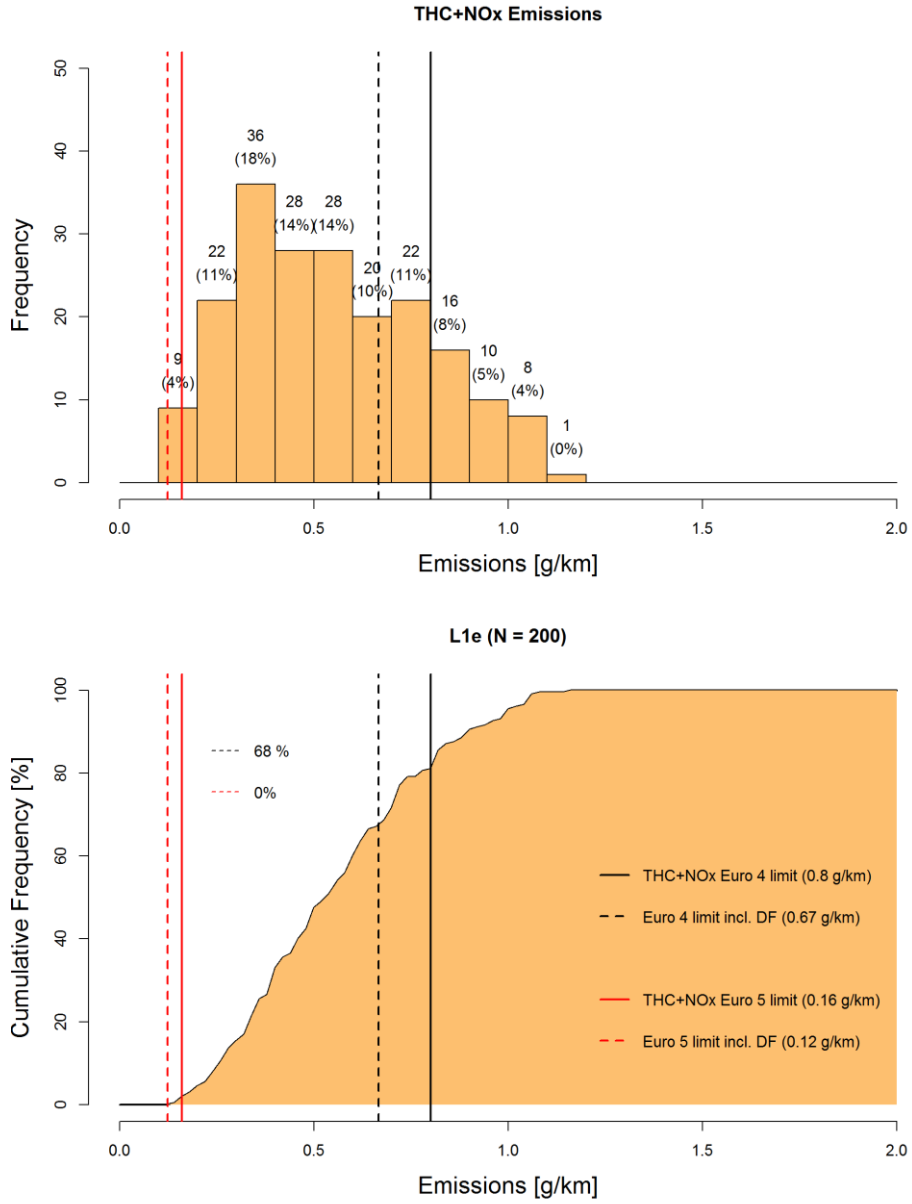

Figure 8: Size-frequency histogram (top) and cumulative percent curves (bottom) of THC+NO_x type I test values for L1e PI models.

Taking into consideration the CO, THC and NO_x type I test emissions together, 126 models complied with Euro 4 CO, and THC+NO_x aggregated limits (including DF), which was equivalent to a share of 63%. Figure 9 displays the repartition of these models by manufacturers. Four models complied with Euro 5 CO, and THC+NO_x added limits (excluding DF), which was equivalent to a share of less than 1%. These four models were provided by one manufacturer, identify as manufacturer "C" in Figure 9.

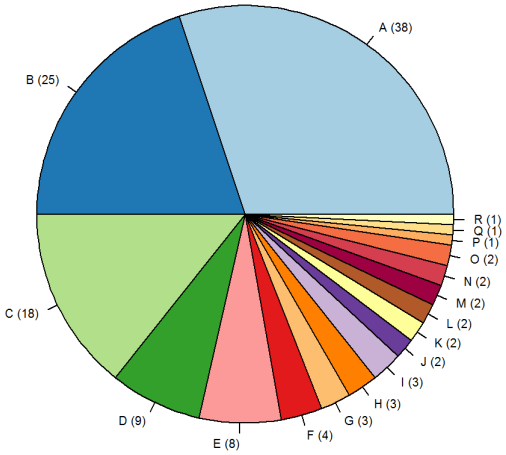

Figure 9: Repartition of the 126 cleanest L1e PI models complying with Euro 4 emission standards (including DF) by manufacturers.

3.2.1.2 Type I test value trend between 2009 and 2014

2009 and 2014 KBA databases were used to perform this analysis. Figure 10 presents type I test values in 2009 and 2014 for L1e category. This notch boxplot is similar to a classical boxplot depicted in Figure 6, with the addition of a notch displaying the confidence interval around the medians of each year. The confidence interval is calculated by multiplying the inter-quartile range (distance between the first and third quartiles) by 1.57, and dividing by the square roots of number of models. If two boxes' notches do not overlap there is 'strong evidence' (95% confidence level) their medians differ.

Between March 2009 and September 2014, CO type I test median value decreased significantly from 0.94 to 0.59 g/km (-37%). However, THC+NO_x type I test median value increased significantly from 0.15 to 0.52 g/km (+246%).

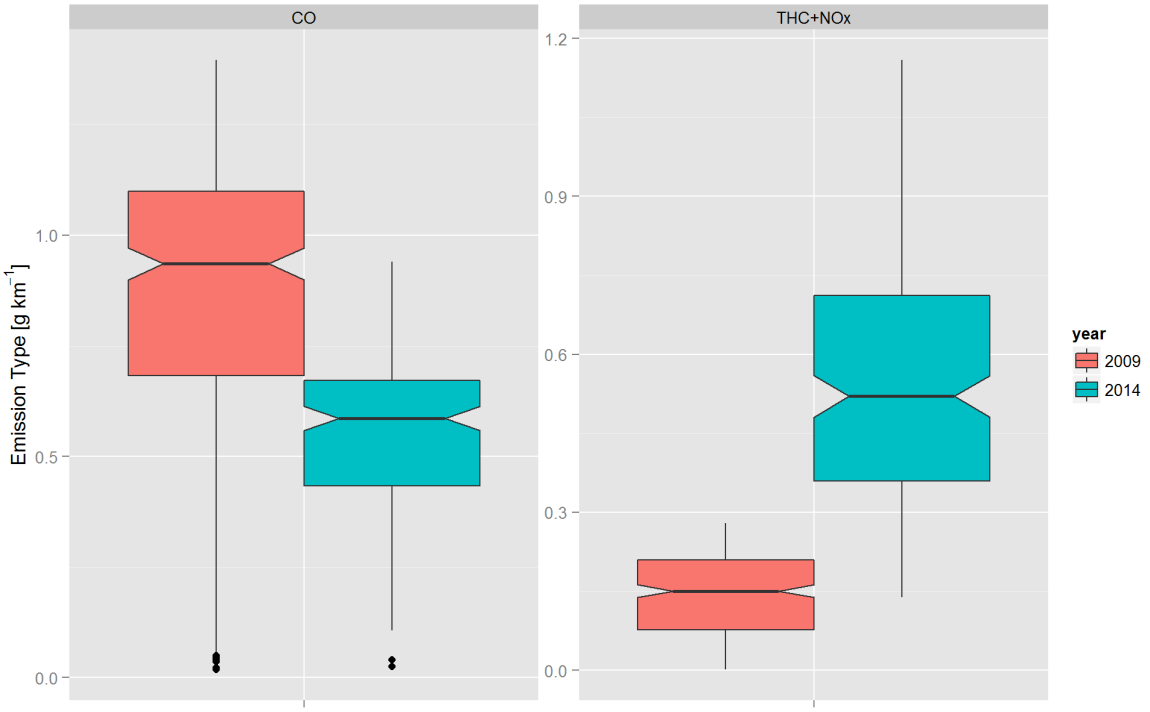

Figure 10: Notch boxplots of L1e type I test values in 2009 and 2014.

3.2.1.3 Top sales models

Figure 11 presents type I test values in 2014 for L1e category, with the projection of the top sales models in EU provided by ACEM (red points). Only half of the 20 top sales models were included in the 2014 KBA database. These 10 top sales models identified in the database accounted for 14% the total sales of L1e vehicle category in EU.

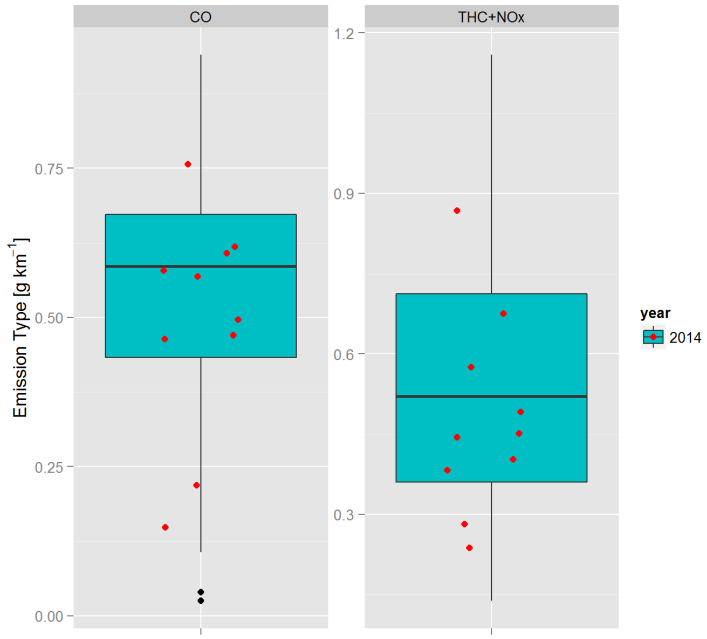

Figure 11: Distribution of the L1e type I test values in 2014, together with the top sales models (red points).

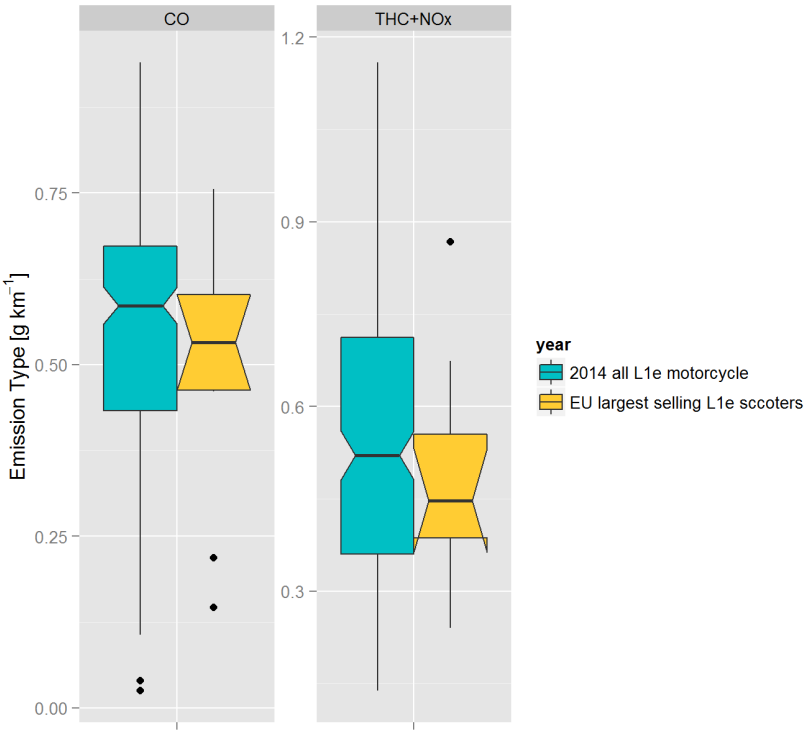

Figure 12: Notch boxplots of L1e type I test values in 2014 compared to the top selling models in EU.

3.2.1.4 Summary for the L1e category models

Based on the 2009, 2014 KBA databases and ACEM top sales data; it was found that for L1e category:

- 89% of the current PI models complied with Euro 5 CO limit (including DF), while no model complied with Euro 5 THC+NO_x added limits (including DF),
- 63% of the current PI models complied with Euro 4 CO, and THC+NO_x added limits (including DF),
- Between March 2009 and September 2014, CO type I test median values decreased significantly by 37%, whereas THC+NO_x type I test median values increased significantly by 246%,
- Top sales models identified in the 2014 KBA database had type I test median values not significantly different than L1e category type I test median values of CO and THC+NO_x.

3.2.2 Three-wheel moped (L2e category)

The 2014 KBA database includes 4 models (after removal of duplicate models) for the L2e category. Among these models, only one has a PI engine while the others were equipped with an electric engine. With a CO and THC+NO_x type I test values of 2.16 and 1.11 g/km respectively, the PI model did not comply with the foreseen Euro 4 limits. Naturally, the 2014 KBA database includes too few L2e models to draw conclusions.

3.2.3 Two-wheel motorcycle (L3e category)

As presented in Table 4, 2014 KBA database included 1742 different models (4961 in total before the removal of duplicate models). The propulsion class share of these models was 1729, 1, 10, 2 for PI, CI, Electric and PI hybrid respectively.

3.2.3.1 Regulated emissions

CO emissions

The PI hybrid models complied with Euro 5 limit including DF (0.77 g/km); and the CI model (0.588 g/km) complied with Euro 4 limit including DF (0.77 g/km), but not with Euro 5 limit including DF (0.38 g/km).

Among PI models, seven had CO emission higher than Euro 2 limit (5.5 g/kg), and 173 models had CO emission higher than Euro 3 limit (2 g/km). Approximately 10% of L3e PI models were not complying with Euro 3 CO standard. The Figure 13 displays the size-frequency histogram and the cumulative percent curves distribution of CO type I test values for the 1730 L3e PI and PI hybrid models. Considering Euro 4 limits of 1.14 g/km and 0.88 g/km including DF (1.3), 31% (530) of the L3e models had CO type I test values below Euro 4 limits including DF. If the 173 models not complying with Euro 3 CO standard were considered as outliers, this share would increase to 34%. Considering Euro 5 limits of 1 g/km and 0.77 g/km including DF (1.3), 23% (393) of the L3e models had CO type I test values below Euro 5 limits including DF. If the 173 models not complying with Euro 3 CO standard were considered as outliers, this share would increase to 25%.

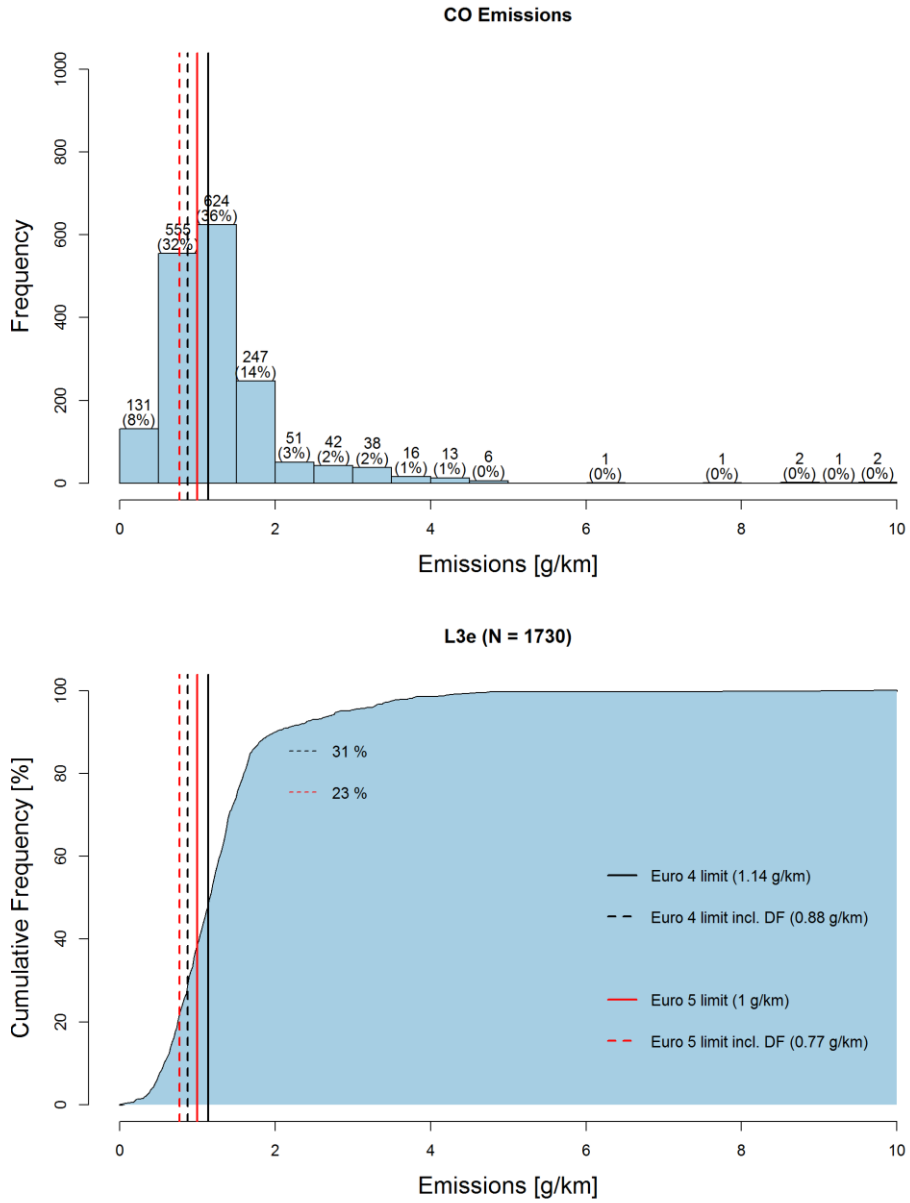

Figure 13: Size-frequency histogram (top) and cumulative percent curves (bottom) of CO type I test values for L3e PI and PI hybrid models.

THC emissions

The PI hybrid models complied with Euro 4 limit including DF (0.316 or 0.14 g/km depending on the v_{max}), but not with Euro 5 limit; and the CI one (0.058 g/km) complied with Euro 5 limit including DF (0.077 g/km).

Among the PI models, 7 had HC emission higher than Euro 3 limit for <150 cm^3 (0.8 g/kg), but fit with Euro 2 limit; and 115 models had HC emission higher than Euro 3 limit for ≥ 150cm^3 (0.3 g/km), some of which were not even complying with Euro 2 limit. Approximately 7% of the PI models were currently not complying with Euro 3 HC standards.

2014 KBA database did not contain the maximum speed v_{max} of the models. For L3e category, v_{max} is a discriminatory factor in Euro 4 and Euro 5 THC and NO_x tailpipe emission limits (engine displacement is currently used as discriminatory factor in Euro 3

legislation). However, 2014 KBA database provided the engine displacement, and an "Emission code number" factor which classified models into 4 sub-categories:

- "0211": models with engine displacement lower than 150 cm^3,
- "0212": models with engine displacement equal or higher than 150 cm^3,
- "0213": models with max velocity lower than 130 km/h,
- "0214": models with max velocity higher than 130 km/h.

The issue was to guess v_{max} from "Emission code number" 0211 and 0212 categories, both together represented 53% of the total L3e category. The engine displacement was used together with the "Emission code number" 0213 and 0214 to investigate if it was possible to infer from these 2 factors the maximum velocity of the model. "Emission code number" 0213 (under 130 km/h) had a share of 73% of engine displacement higher than 150 cm^3, whereas "Emission code number" 0214 (above 130 km/h) had a share of 100% of engine displacement higher than 150 cm^3 (ranging from 250 to 2300 cm^3). Consequently, it was assumed that "Emission code number" 0211 (engine displacement under 150cc) contained 100% of models with a maximum velocity lower than 130 km/h category, however, it was not possible to split into above and below 130 km/h the models classified under "Emission code number" of 0212.

Considering this issue, it was decided to confront THC type I test values to Euro 4 standards at v_{max} ≥130 km/h for PI/PI hybrid, which is more stringent (0.17 g/kg) in comparison with L3e vehicles with v_{max} <130 km/h (0.38 g/km). Therefore, the subsequent output will be pessimistic. However, this decision did not have an impact for Euro 5 emissions standards as the latter are not related to the maximum velocity of the models.

Figure 14 displays the size-frequency histogram and the cumulative percent curves distribution of THC type I test values for the 1729 L3e PI and PI hybrid models. Considering Euro 4 limits of 0.17 g/km and 0.14 g/km including DF (1.2), 38% (649) of the L3e models had THC type I test values below Euro 4 limits including DF. If the 122 models not complying with Euro 3 THC standards were considered as outliers, this share would increase to 40%. Considering Euro 5 limits of 0.1 g/km and 0.077 g/km including DF (1.3), 7% (121) of the L3e models had THC type I test below Euro 5 limits including DF. If the 122 models not complying with Euro 3 THC standard were considered as outliers, this share would increase to 8%.

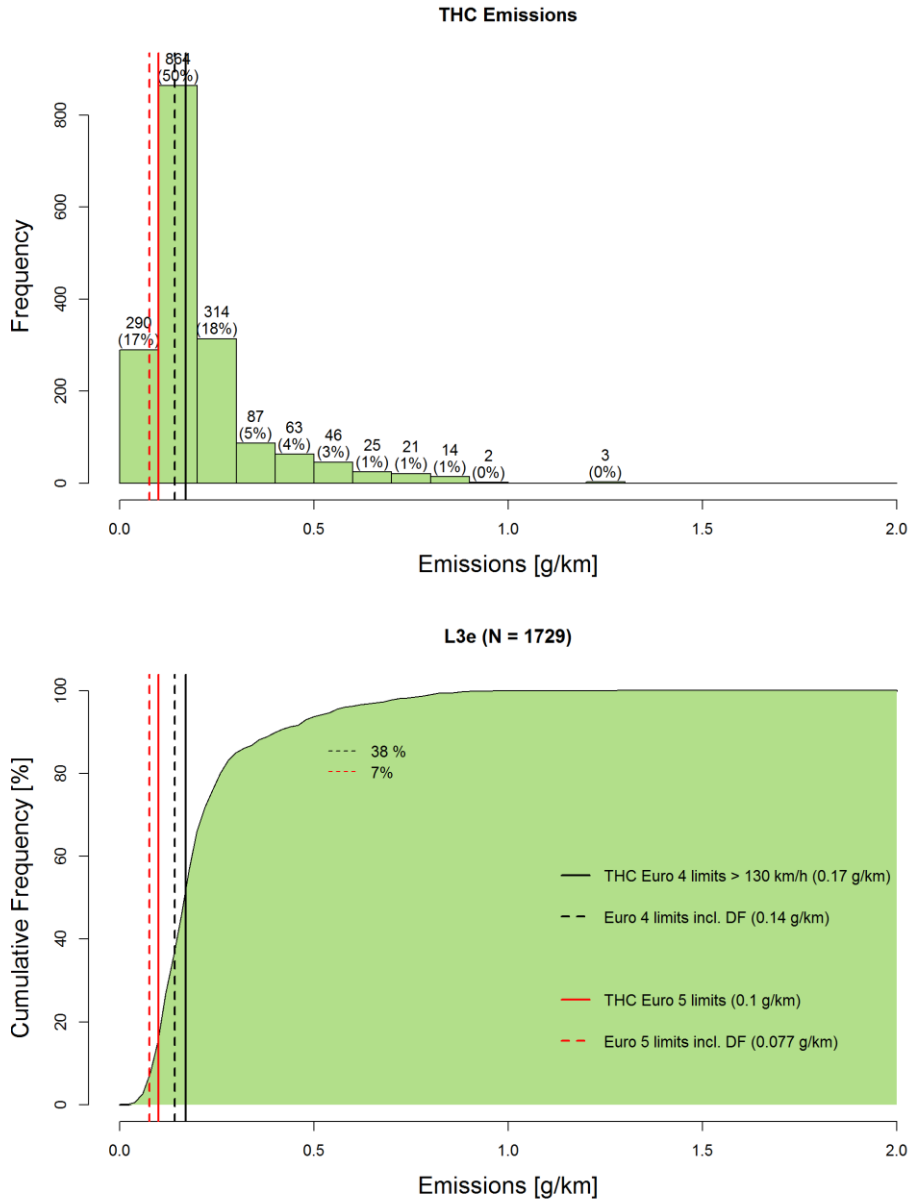

Figure 14: Size-frequency histogram (top) and cumulative percent curves (bottom) of THC type I test values for L3e PI and PI hybrid models.

<u>NO_x emissions</u>

The PI hybrid models complied with Euro 3 limit (0.15 g/km); and the CI one (0.423 g/km) did not comply with this same Euro 3 limit.

Among the PI models, 169 had NO_x emissions higher than Euro 3 limit. Approximately 10% of the PI models were currently not complying with Euro 3 NO_x standard.

In order to be consistent with the decision taken for THC emissions, NO_x type I test were confronted to Euro 4 standards for models with v_{max}≥130 km/h, which was less stringent (0.09 g/kg) in comparison with L3e models v_{max}<130 km/h (0.07 g/km). Therefore, the subsequent output will be optimistic. In the same way as for THC standard, this decision did not have an impact for Euro 5 NO_x emissions standards as the latter is not related to the maximum velocity of the model.

Figure 15 displays the size-frequency histogram and the cumulative percent curves distribution of NO_x type I test values for the 1729 L3e PI and PI hybrid models. Considering Euro 4 limits of 0.09 g/km and 0.075 g/km including DF (1.2), 38% (657) of the L3e models had NO_x type I test values below Euro 4 limits including DF. If the 169 models not complying with Euro 3 NO_x standards were considered as outliers, this share would increase to 41%. Considering Euro 5 limits of 0.06 g/km and 0.046 g/km including DF (1.3), 14% (235) of the L3e models had NO_x type I test values below Euro 5 limits including DF. If the 169 models not complying with Euro 3 NO_x standard were considered as outliers, this share would increase to 15%.

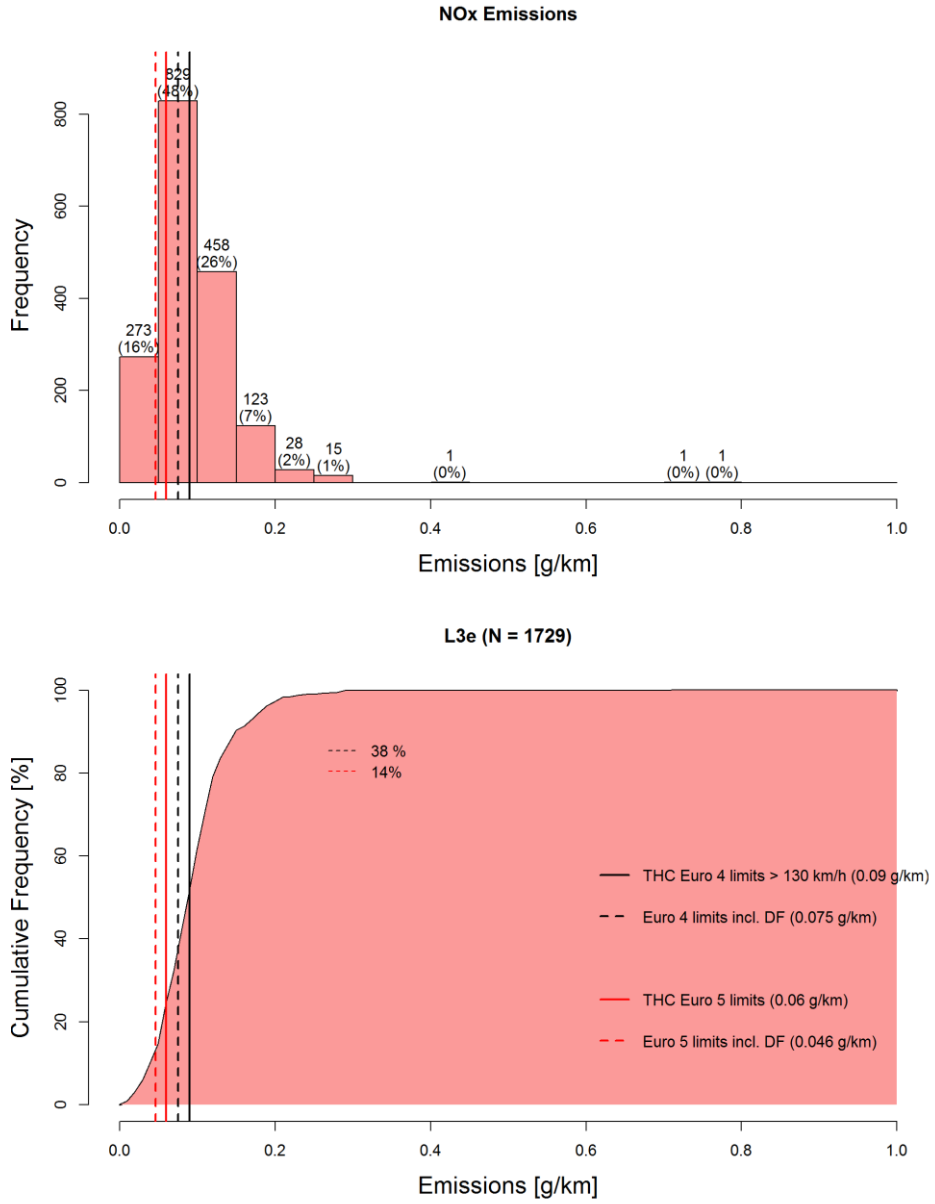

Figure 15: Size-frequency histogram (top) and cumulative percent curves (bottom) of NO_x type I test values for L3e PI and PI hybrid models.

Taking into consideration the CO, THC and NO_x type I test emissions together, 134 models complied with Euro 4 CO, THC and NO_x standards (including DF), which was equivalent to a share of 8%. Figure 16 displays the repartition of these models by manufacturers. 16 models complied with Euro 5 CO, THC and NO_x standards (including

DF), which was equivalent to a share of less than 1%. Figure 17 displays the repartition of these models by manufacturers.

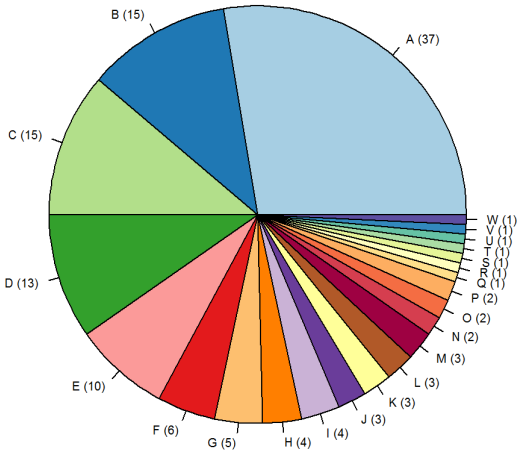

Figure 16: Repartition of the 134 cleanest L3e PI and PI hybrid models complying with Euro 4 emission standards (including DF) by manufacturers.

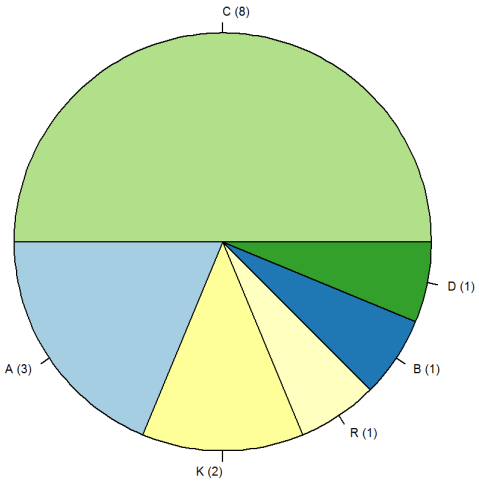

Figure 17: Repartition of the 16 cleanest L3e PI and PI hybrid models complying with Euro 5 emission standards (including DF) by manufacturers.

3.2.3.2 Type I test value trend between 2009 and 2014

2009 and 2014 KBA databases were used to perform this analysis. Models identified as outliers in the previous section were removed. Figure 18 presents type I test values in 2009 and 2014 for L3e category. In the same way as for the L1e category, this notch boxplot is similar to a classical boxplot, with the addition of a notch displaying the confidence interval around the medians (95% confidence level).

Between March 2009 and September 2014, it was found:

- CO type I test median value increased significantly from 0.62 to 1.08 g/km (+75%),
- THC type I test median value decreased significantly from 0.34 to 0.16 g/km (-53%),

- NOx type I test median value decreased significantly from 0.16 to 0.08 g/km (-50%).

This 5-year trend for each pollutant might enlighten on what could be the foreseen type I test values at the date of application of Euro 4 and Euro 5 Regulations.

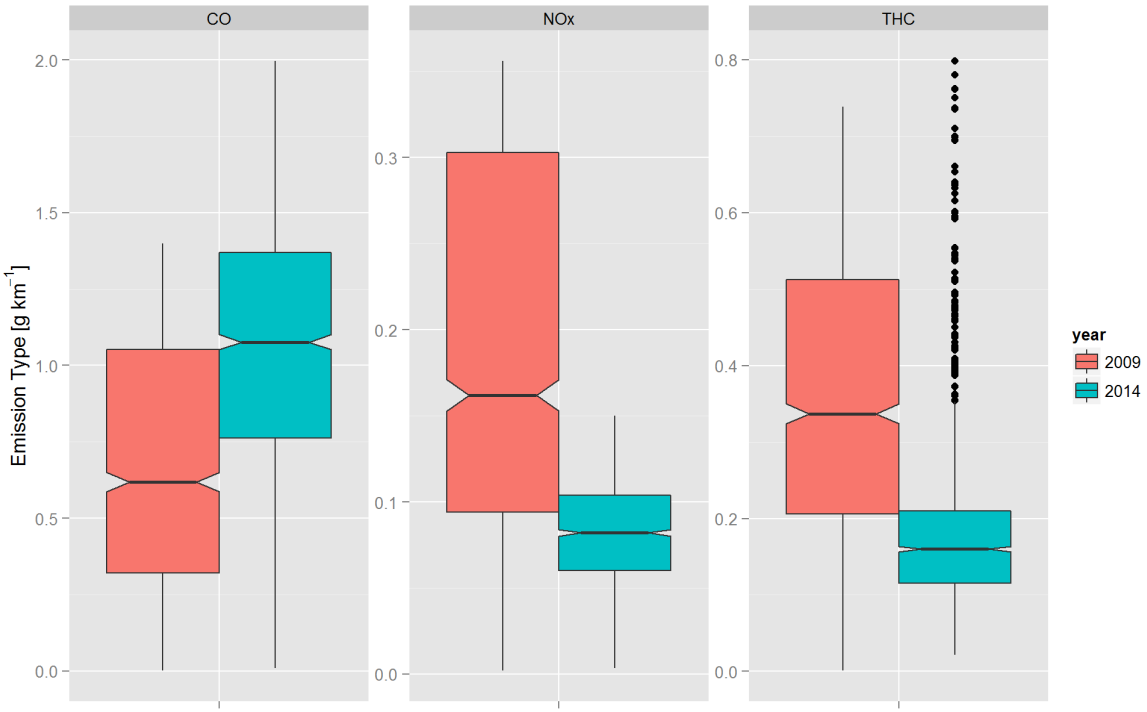

Figure 18: Notch boxplots of L3e type I test values in 2009 and 2014.

3.2.3.3 Top sales models

Figure 11 presents type I test values in 2014 for L1e category, with the projection of the top sales models provided by ACEM (red points). Only half of the 20 top sales models were included in the 2014 KBA database. These 10 top sales models identified in the database accounted for 14% the total sales of L1e vehicle category in EU.

Figure 19 presents type I test values in 2014 for L3e category, with the projection of the top sales models in EU provided by ACEM. Almost all the 20 top sales models were included in the 2014 KBA database. These models accounted for 36% and 19% of the total sales of L3e-A1 and L3e-A2+A3 vehicle categories, respectively.

Figure 20 presents type I test values in 2014 for L3e category compared to the top sales models. CO and NO_x type I test median value from top selling models were significantly lower than type I test median value of L3e category (95% confidence). No significant difference was found for THC type I test value.

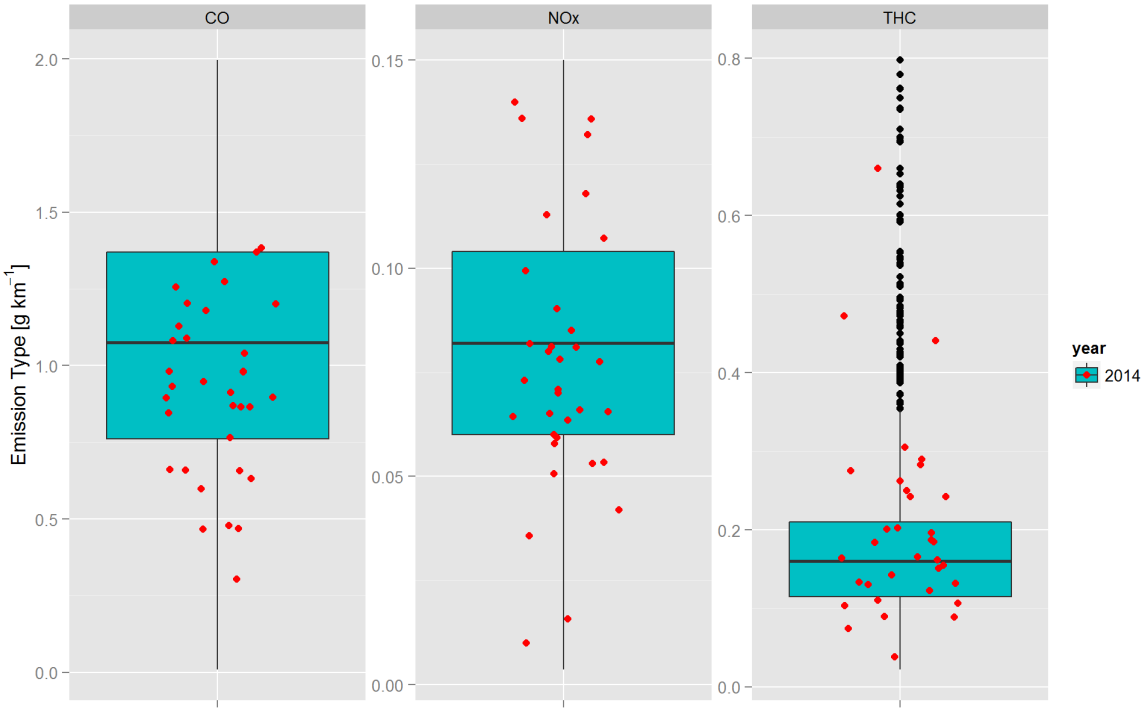

Figure 19: Distribution of the L3e type I test values in 2014, together with the top sales models (red points).

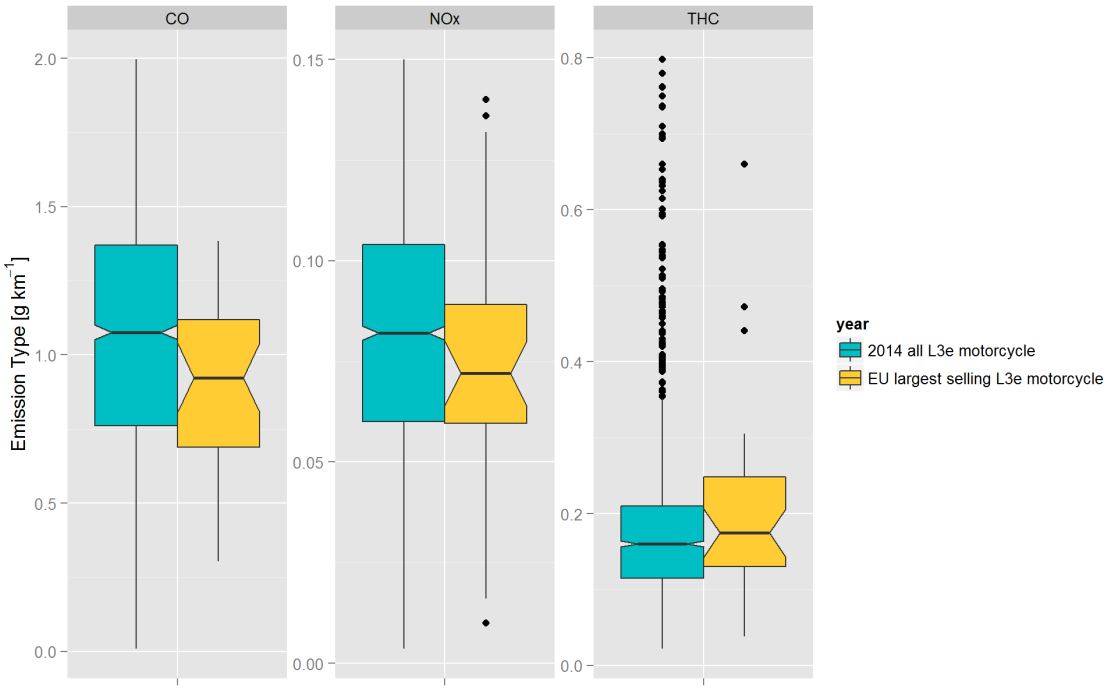

Figure 20: Notch boxplots of L3e type I test values in 2014 compared to the top selling models in EU.

3.2.3.4 Summary for the L3e category models

Based on the 2009, 2014 KBA databases and ACEM top sales data; it was found that for L3e category:

- 8% of the current PI and PI hybrid models complied with Euro 4 CO, THC and NO_x standards (including DF),
- Less than 1% of the current PI and PI hybrid models complied with Euro 5 CO, THC and NO_x standards (including DF),
- Between March 2009 and September 2014, CO type I test median value increased significantly by 75%, whereas THC and NO_x type I test median values decreased significantly by 53% and -50% respectively,
- Top sales models had type I test median values significantly lower than L3e category type I test median values for CO and NO_x. However, no significant difference was found for THC type I test values.

3.2.4 Powered tricycle (L5e category)

As presented in Table 4, 2014 KBA database included 48 different models (108 in total before the removal of duplicate models). The propulsion class share of these models was 41, 4, 2, 1 for PI, CI, Electric and PI hybrid respectively.

As detailed in Table 3, Reg. 168 proposes different emissions limits depending on the L5e sub-category (i.e. L5e-A, and B), on the propulsion class (PI, CI), and on the maximum velocity of the models (for PI/PI hybrid L5e-A). Regarding Euro 4 emission limits, 2014 KBA database did not provide sufficient technical description to enable the classification of the models into these sub-categories. Therefore, Type I test values were compared to the more stringent Euro 4 emission limits in the subsequent analysis (proposed for the L5e-A sub-category). Thus, subsequent output related to Euro 4 limits will be pessimistic. However, this decision did not have an impact for Euro 5 emissions standards.

3.2.4.1 Regulated emissions

CO emissions

Among the CI models, three of the four complied with Euro 4 CO limit including DF (0.77 g/km); and the fourth model complied with the Euro 5 CO limit including DF (0.38 g/km).

The Figure 21 displays the size-frequency histogram and the cumulative percent curves distribution of CO type I test values for the 42 L5e PI and PI hybrid models. Considering Euro 4 limits of 1.14 g/km and 0.88 g/km including DF (1.3), 26% (11) of the L5e models had CO type I test values below Euro 4 limit (for L5e-A) including DF. Considering Euro 5 limits of 1 g/km and 0.77 g/km including DF (1.3), 24% (10) of the L5e models had CO type I test values below Euro 5 limit including DF.

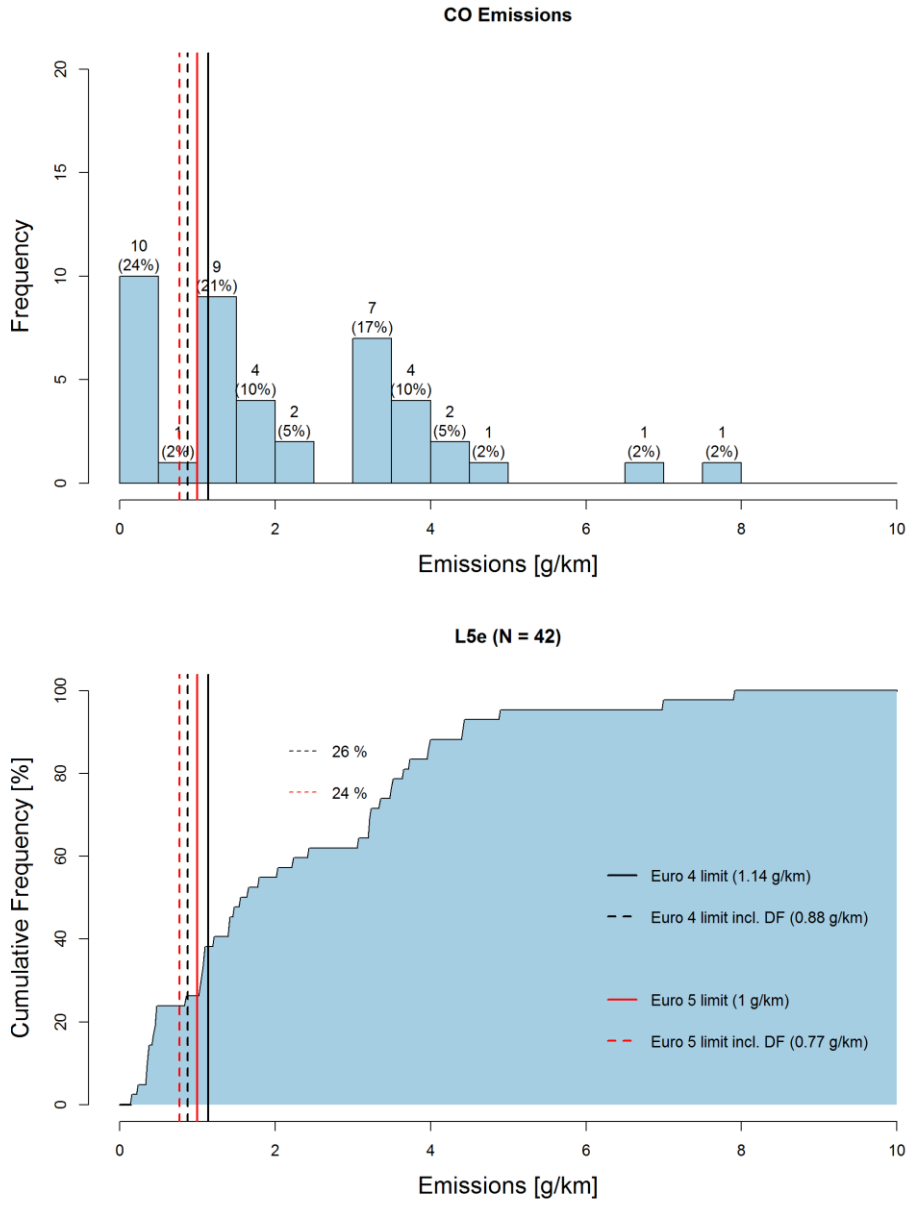

Figure 21: Size-frequency histogram (top) and cumulative percent curves (bottom) of CO type I test values for L5e PI and PI hybrid models.

THC emissions

Among the CI models, two of the four models complied with Euro 5 THC limit including DF (0.09 g/km), 1 model complied with Euro 4/5 THC limit excluding DF (0.1 g/km); and one model was above Euro 4/5 the Euro 5 THC limit excluding DF.

Figure 22 displays the size-frequency histogram and the cumulative percent curves distribution of THC type I test values for the 42 L5e PI and PI hybrid models. Considering Euro 4 limits of 0.17 g/km and 0.14 g/km including DF (1.2), 38% (16) of the L5e models had THC type I test values below Euro 4 limit (for L5e-A with $v_{max} \geq 130$ km/h) including DF. Considering Euro 5 limits of 0.1 g/km and 0.077 g/km including DF (1.3), 14% (6) of the L5e models had THC type I test values below Euro 5 limit including DF.

Figure 14 displays the size-frequency histogram and the cumulative percent curves distribution of THC type I test values for the 1729 L3e PI and PI hybrid models. Considering Euro 4 limits of 0.17 g/km and 0.14 g/km including DF (1.2), 38% (649) of the L3e models had THC type I test values below Euro 4 limits including DF. If the 122 models not complying with Euro 3 THC standards were considered as outliers, this share would increase to 40%. Considering Euro 5 limits of 0.1 g/km and 0.077 g/km including DF (1.3), 7% (121) of the L3e models had THC type I test below Euro 5 limits including DF. If the 122 models not complying with Euro 3 THC standard were considered as outliers, this share would increase to 8%.

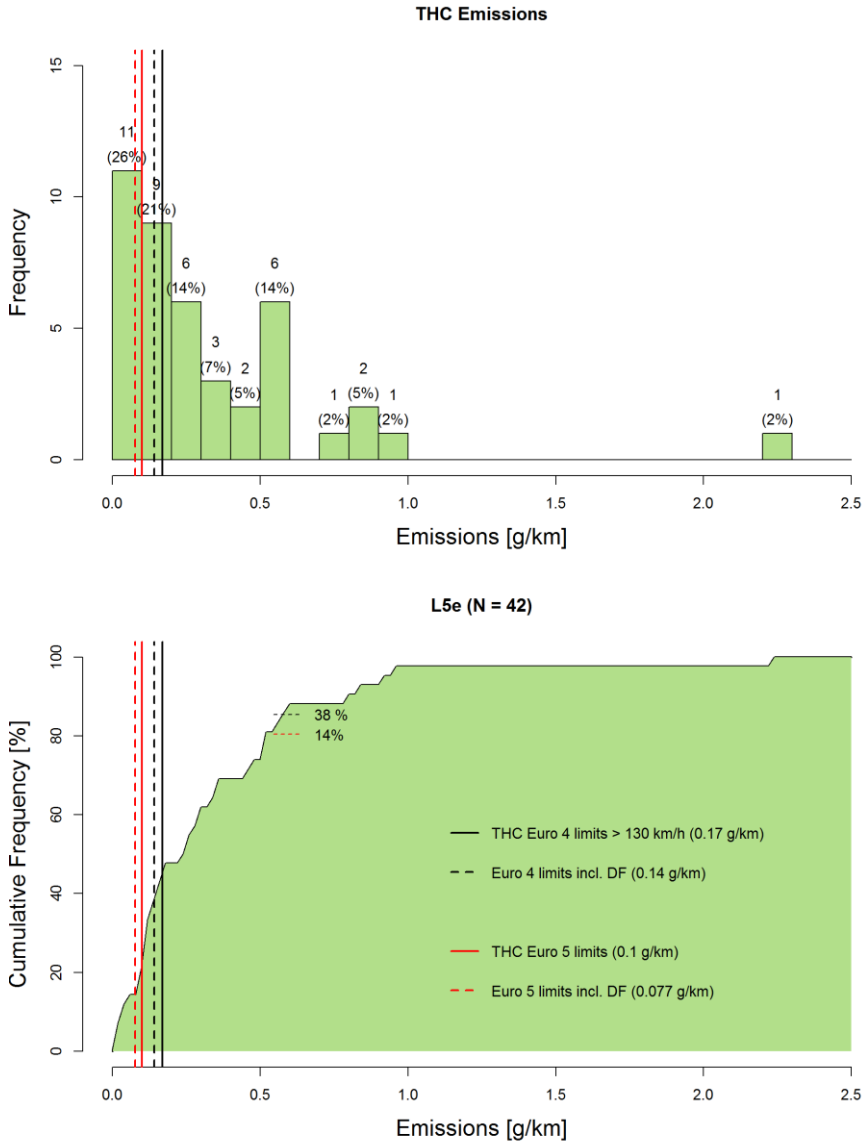

Figure 22: Size-frequency histogram (top) and cumulative percent curves (bottom) of THC type I test values for L5e PI and PI hybrid models.

NO_x emissions

Among the CI models, with a minimum NO_x type I test value of 0.37 g/km, no model complied with Euro 4 NO_x limit excluding DF (0.3 g/km).

Figure 23 displays the size-frequency histogram and the cumulative percent curves distribution of NO_x type I test values for the 42 L5e PI and PI hybrid models. Considering Euro 4 limits of 0.07 g/km and 0.06 g/km including DF (1.2), 31% (13) of the L5e models had NO_x type I test values below Euro 4 limit (for L5e-A with v_{max} < 130 km/h) including DF. Considering Euro 5 limits of 0.06 g/km and 0.05 g/km including DF (1.3), 26% (11) of the L5e models had NOx type I test values below Euro 5 limit including DF.

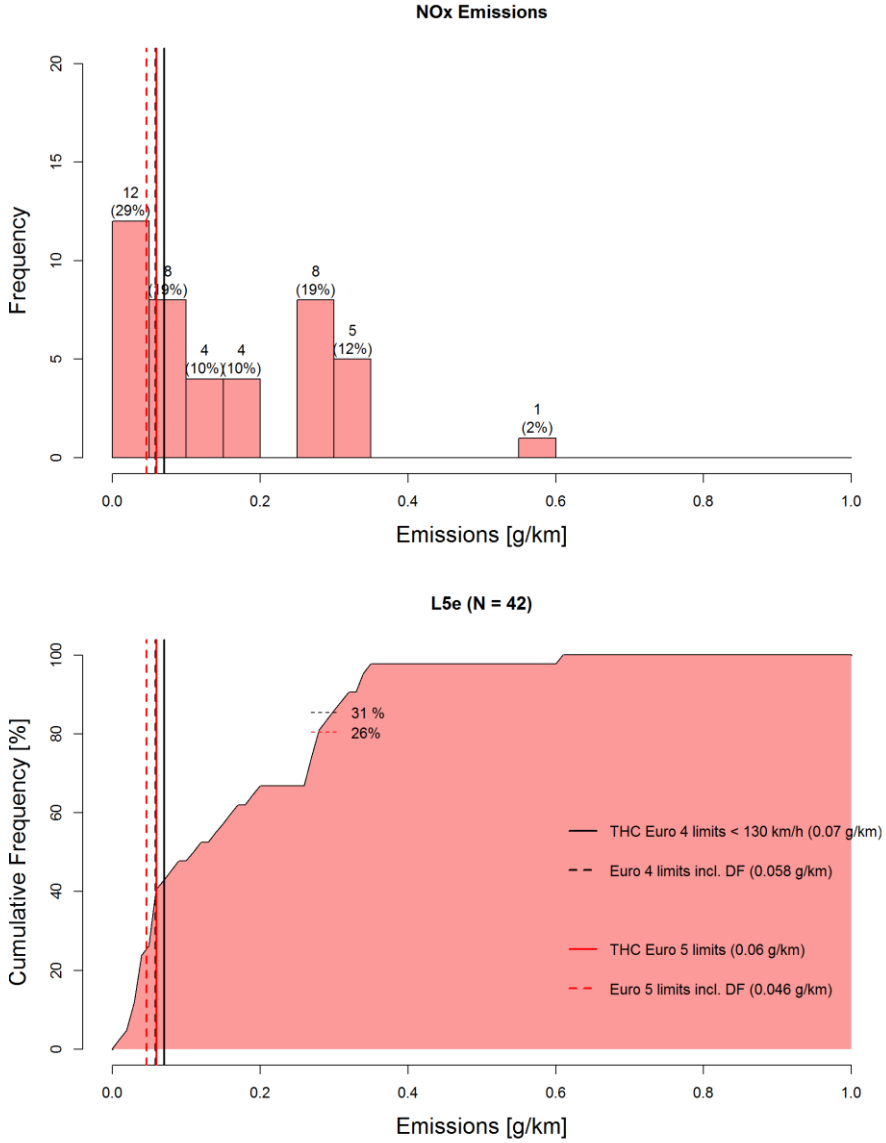

Figure 23: Size-frequency histogram (top) and cumulative percent curves (bottom) of NO_x type I test values for L5e PI and PI hybrid models.

Taking into consideration the CO, THC and NO_x type I test emissions together, 3 models complied with Euro 4 CO, THC and NO_x standards (including DF), which was equivalent to a share of 7%. Figure 24 displays the repartition of these models by manufacturers. 16 models complied with Euro 5 CO, THC and NO_x standards (including DF), which was equivalent to a share of less than 1%. Figure 17 displays the repartition of these models

by manufacturers. Two models complied with Euro 5 CO, THC and NO_x standards (including DF), which was equivalent to a share of 4%. These two models were provided by the manufacturers identified as "A" and "B" in Figure 24.

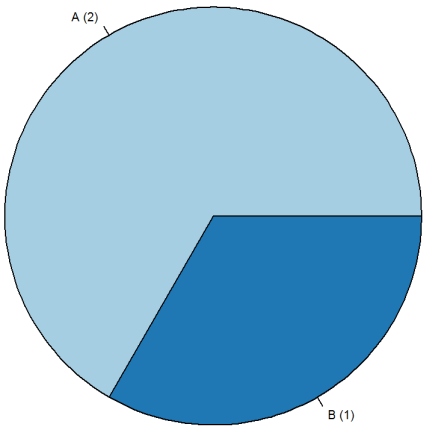

Figure 24: Repartition of the 3 cleanest L5e PI and PI hybrid models complying with Euro 4 emission standards (including DF) by manufacturers.

3.2.4.2 Summary for the L5e category models

Based on the 2014 KBA database, it was found that for L5e category:

- 7% of the current PI and PI hybrid models complied with Euro 4 CO, THC and NO_x standards (including DF),
- 4% of the current PI and PI hybrid models complied with Euro 5 CO, THC and NO_x standards (including DF).

3.2.5 Light quadricycle (L6e category)

The 2014 KBA database includes 4 models (after removal of duplicate models) for the L6e category. Among these models, two have a PI engine while the others were equipped with an electric engine. With a CO and THC+NO_x type I test values of 0.564 and 0.696 g/km respectively, the PI models complied with the foreseen CO Euro 5 limit including DF (0.77 g/km), and with the foreseen THC+NO_x Euro 4 limit including DF (0.75 g/km). Naturally, the 2014 KBA database includes too few L6e models to draw conclusions.

3.2.6 Heavy quadricycle (L7e category)

As presented in Table 4, 2014 KBA database included 107 different models (190 in total before the removal of duplicate models). The propulsion class share of these models was 101, 3, 3, 0 for PI, CI, Electric and PI hybrid respectively.

As detailed in Table 3, Reg. 168 proposes different emissions limits depending on the L7e sub-category (i.e. L7e-A, B, and C), on the propulsion class (PI, CI), and on the maximum velocity of the models (for PI/PI hybrid L7e-A). Regarding Euro 4 emission

limits, 2014 KBA database did not provide sufficient technical description to enable the classification of the models into these sub-categories. Therefore, Type I test values were compared to the more stringent Euro 4 emission limits in the subsequent analysis (proposed for the L7e-A sub-category). Thus, subsequent output related to Euro 4 limits will be pessimistic. However, this decision did not have an impact for Euro 5 emissions standards.

3.2.6.1 Regulated emissions

CO emissions

Among the CI models, two of the three complied with Euro 4 CO limit excluding DF (1 g/km); while one model was slightly above the Euro 4 limit (1.078 g/km).

The Figure 25Figure **21** displays the size-frequency histogram and the cumulative percent curves distribution of CO type I test values for the 101 L7e PI models. Considering Euro 4 limits of 1.14 g/km and 0.88 g/km including DF (1.3), 14% (14) of the L7e models had CO type I test values below Euro 4 limit (for L7e-A) including DF. Considering Euro 5 limits of 1 g/km and 0.77 g/km including DF (1.3), 8% (8) of the L7e models had CO type I test values below Euro 5 limit including DF.

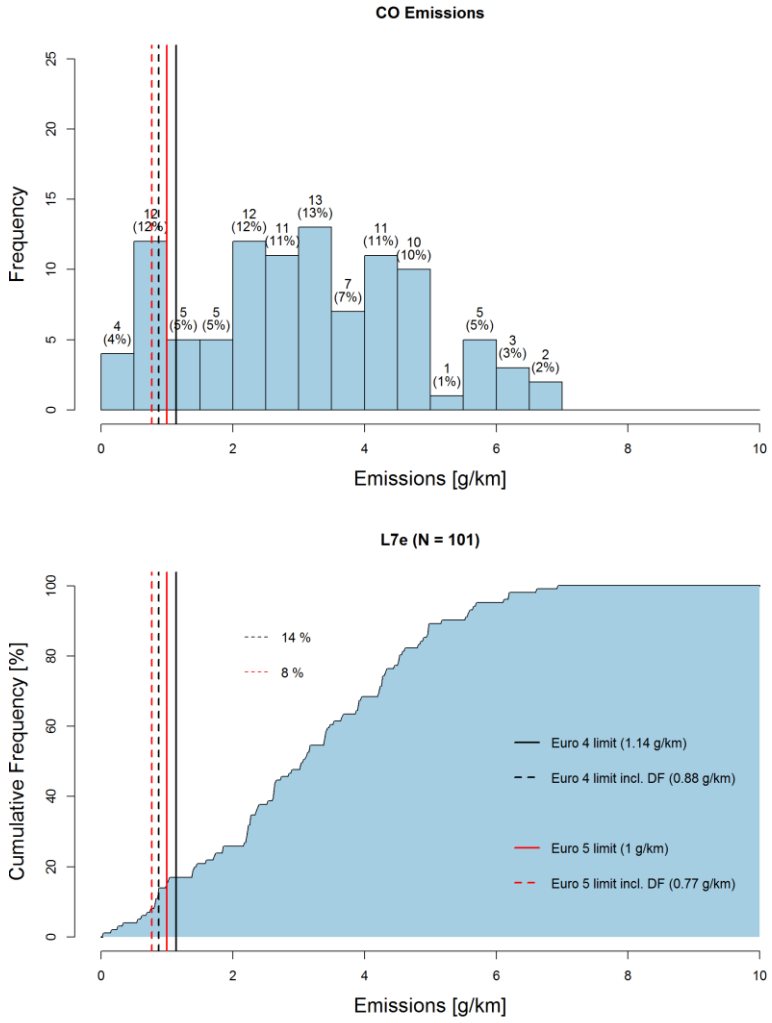

Figure 25: Size-frequency histogram (top) and cumulative percent curves (bottom) of CO type I test values for L7e PI models.

THC emissions

Among the CI models, one of the three models complied with Euro 4 THC limit including DF (0.083 g/km), one model complied with Euro 4 THC limit excluding DF (0.1 g/km); and one model was 30% above the Euro 4 limit (type I test value = 0.129 g/km).

Figure 26 displays the size-frequency histogram and the cumulative percent curves distribution of THC type I test values for the 101 L7e PI models. Considering Euro 4 limits of 0.17 g/km and 0.14 g/km including DF (1.2), 24% (24) of the L7e models had THC type I test values below Euro 4 limit (for L7e-A with $v_{max} \geq 130$ km/h) including DF. Considering Euro 5 limits of 0.1 g/km and 0.077 g/km including DF (1.3), 10% (10) of the L7e models had THC type I test values below Euro 5 limit including DF.

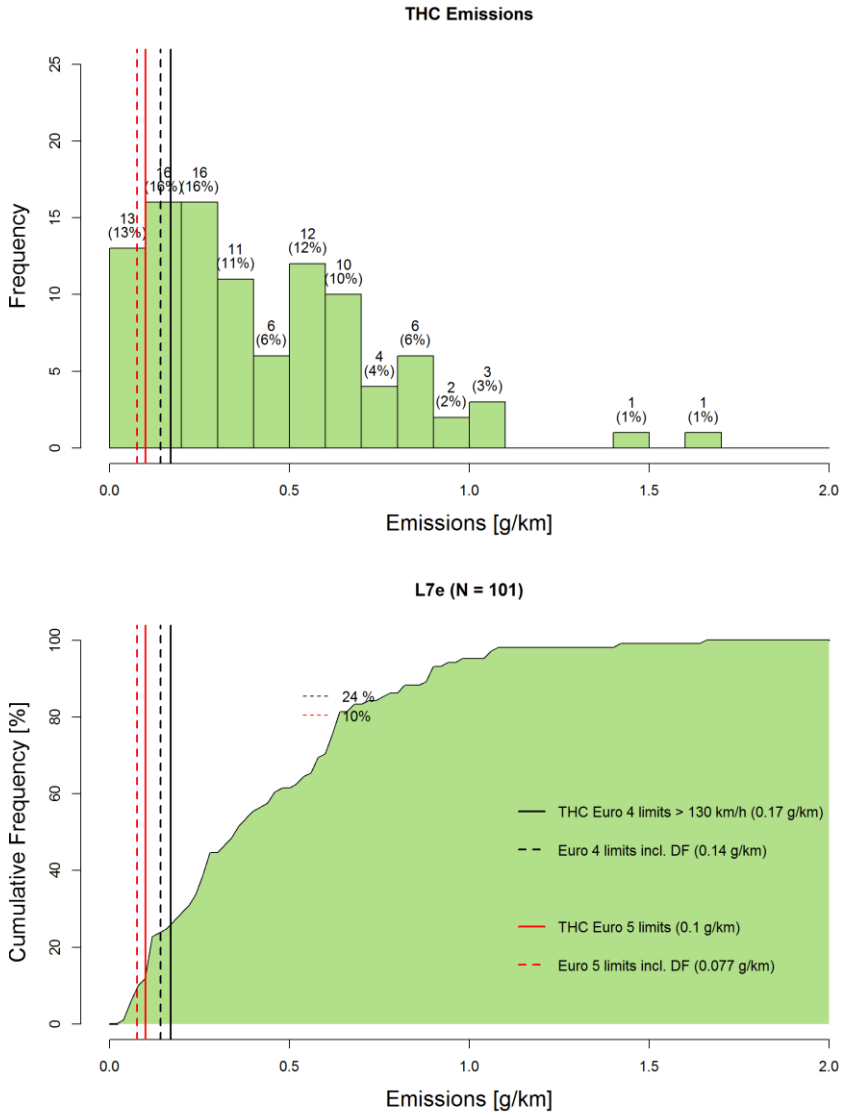

Figure 26: Size-frequency histogram (top) and cumulative percent curves (bottom) of THC type I test values for L7e PI models.

$\underline{NO_x}$ emissions

Among the CI models, with a minimum NO_x type I test value of 0.5 g/km, no model complied with Euro 4 NO_x limit excluding DF (0.3 g/km for L7e-A).

Figure 27 displays the size-frequency histogram and the cumulative percent curves distribution of NO_x type I test values for the 101 L7e PI models. Considering Euro 4 limits of 0.07 g/km and 0.06 g/km including DF (1.2), 3% (3) of the L7e models had NO_x type I test values below Euro 4 limit (for L7e-A with v_{max} < 130 km/h) including DF. Considering Euro 5 limits of 0.06 g/km and 0.05 g/km including DF (1.3), 2% (2) of the L7e models had NOx type I test values below Euro 5 limit including DF.

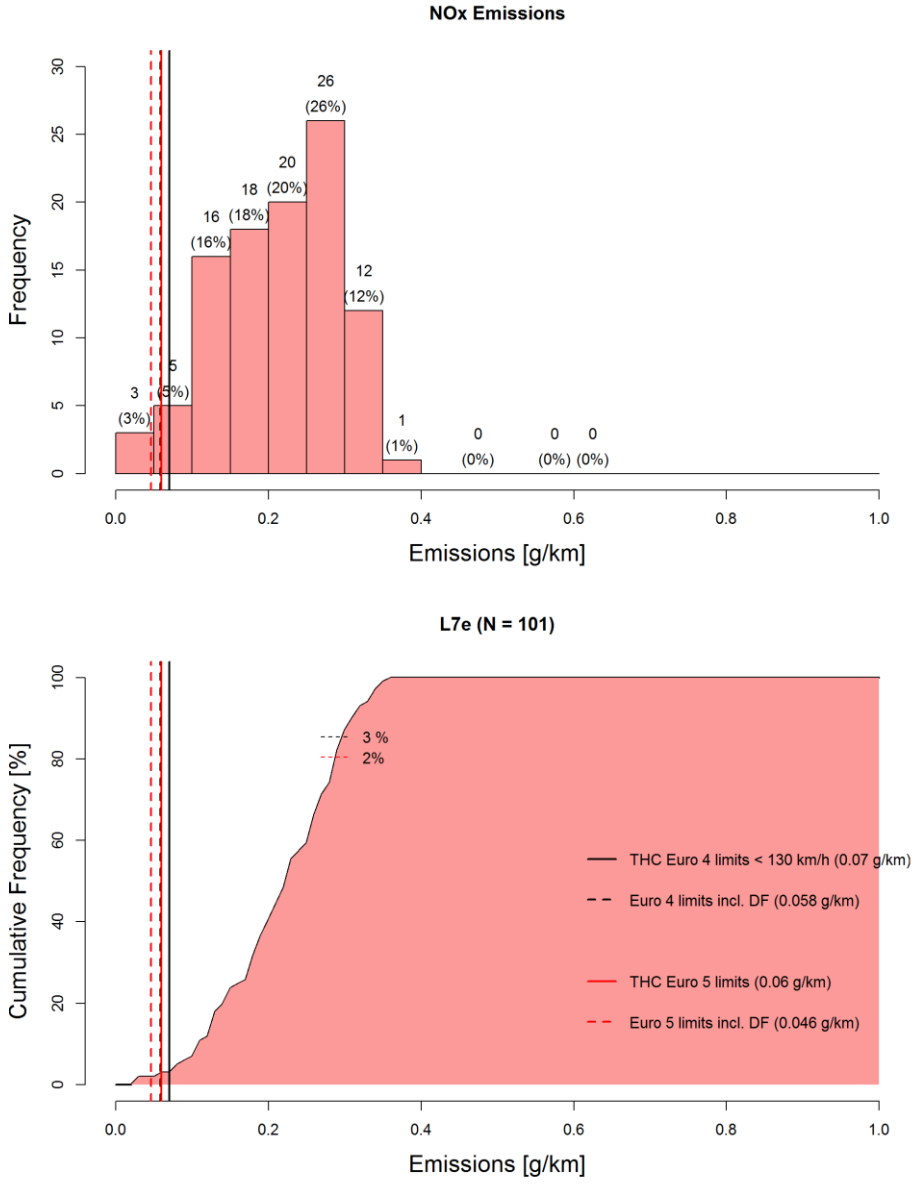

Figure 27: Size-frequency histogram (top) and cumulative percent curves (bottom) of NO_x type I test values for L7e PI models.

Taking into consideration the CO, THC and NO_x type I test emissions together, no model complied with Euro 4 CO, THC and NO_x standards (including DF). If NO_x standard was not considered, 11 models were identified as the cleanest models, which was equivalent to a share of 11%. Figure 28 displays the repartition of these models by manufacturers.

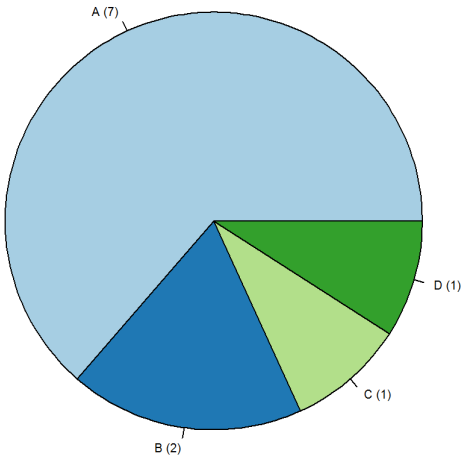

Figure 28: Repartition of the 11 cleanest L7e PI models complying with CO and THC Euro 4 emission standards (including DF) by manufacturers.

3.2.6.2 Summary for the L7e category models

Based on the 2014 KBA database, it was found that for L7e category:

- 14%, 24% and 3% of the current models complied with the most stringent Euro 4 CO, THC and NO_x standards (including DF) respectively.
- 8%, 10% and 2% of the current models complied with Euro 5 CO, THC and NO_x standards (including DF) respectively.
- No model complied with CO, THC and NO_x most stringent Euro 4 standards (including DF). However, without considering NO_x standards, 11 models were identified as the cleanest models.

3.2.7 Conclusions on type I test values of current L-category vehicles in EU

First of all, the dataset used for this study provided insight in emission overview from actual L1e-B, L3e, L5e and L7e model categories. Other model categories (L2e, L4e, and L6e) were not sufficiently represented in the KBA database to draw any conclusion. In addition, the scope of this analysis is limited to the products sold in the German market. However, these findings provide clarification and good understanding of what is the state of play of type I test values, and how large is the gap with the foreseen standards.

Among the categories covered by this study, L1e-B appeared to be the nearest to Euro 4 emission limits, with 63% share of model complying with this standard. However, it has to be borne in mind that THC and NO_x were treated together as the sum of these two pollutants is currently regulated.

L3e and L5e categories displayed a lower share of model complying with Euro 4 standard (8% and 7% respectively) in comparison with L1e-B category. However, unlike the L1e-B category, these categories presented models complying with Euro 5 standards, with a share of 1% and 4% for L3e and L5e respectively. In addition, L3e top sales models appeared to be associated to significantly lower CO and NO_x type I test values than the full L3e models displayed in the 2014 KBA database.

L7e category displayed model complying neither with Euro 4, nor Euro 5 standards. Table 5 summarizes these main findings.

Table 5: Summary of the current type I test values of L-category vehicles against the foreseen Euro 4 and Euro 5 limits proposed in Reg. 168 (data from the 2014 KBA database).

Vehicle Category	Number after removal of duplicate models*	Euro 4 including DF	Euro 5 Including DF
L1e*	257	63%	0%
L3e	1742	8%	1%
L5e	48	7%	4%
L7e	107	0%**	0%

* *THC and NO_x type I test values treated together*

** *11% if NO_x standard not considered*

It is important to point out that type I test values were compared to the foreseen Euro 4 and 5 "Tailpipe emission limits after cold start", regardless of the test cycle associated (e.g. R47 or R40). Even if some correction factors are currently available (i.e. for L3e category [19]), none of them were used in this study. Consequently, the figures displayed here may be optimistic, in particular for the vehicle categories which, in the current legislation, not fully include the cold start in the type I test cycle (i.e. L1e-B).

4. Conclusion and recommendations

This report aims at collecting stocktaking of representative data among L-category vehicles placed on the EU market, as well as analyzing currently available type-approval data.

- From the stocktaking collected, it was found that very scarce data related to other L-categories than L1e and L3e are currently available. The poor quality of available data is even more striking when compared to the detailed data set available for passenger cars for instance. In addition, discrepancies were found in terms of vehicle stock and new registration between the different sources collected, in particular for moped category. The Commission should encourage member states to provide updated figures for the new registrations broken down by sub-cat, even retroactive, as new registrations are the basis for the circulating park status and projections. Detailed data from different sources and mutually agreed upon may improve model projections, and guarantee unbiased cost-benefit analysis of the Euro 5 step of L-category vehicles (i.e. for both OEMs and the responsible legal body).

- From the datamining on type I test values from L-category vehicles, the overview was achieved for actual L1e-B, L3e, L5e and L7e categories as other categories (L2e, L4e, and L6e) were not sufficiently represented in the KBA database. Assuming the L-category vehicles sold in the German market as representative, it was found that L1e-B was the category displaying the highest share of models with type I test values lower than Euro 4 emission limits (68%). However, it has to be borne in mind that THC and NO_x were treated together in this study as the sum of these pollutants are regulated until Euro 3 standard. L3e and L5e categories displayed a lower share of model complying with Euro 4 standard (8% and 7% respectively) in comparison with L1e-B category. However, these categories presented models already complying with Euro 5 standards. Finally, L7e category displayed model complying neither with Euro 4, nor Euro 5 standards. Among the L-categories, L7e may have to make the most significant effort to comply with the foreseen Euro 4 and Euro 5 standard.

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List of abbreviations

ACEM	European Association of Motorcycle Manufacturers
CI	Compressed Ignition
CO	Carbon Monoxide
DF	Deterioration Factor
DG GROW	Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs
EC	European Commission
EU	European Union
EU28	Member countries of the European Union
HC	Hydrocarbons
JRC	Joint Research Centre
KBA	Kraftfahrt-Bundesamt
NMHC	Non-Methane Hydrocarbons
NO_x	Nitrogen Oxides
O_3	Ozone
PI	Positive Ignition
PM	Particulate Matter
THC	Total Hydrocarbons

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