

OVERALL VEHICLE REQUIREMENTS

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1 EXECUTIVE SUMMARY

After the exploration of the user needs, the definition of target markets and the analysis of the legislations, regulations and standards in the first work package (WP1) the basic requirements for each of the three vehicle concepts which are going to be developed in EU-LIVE are defined in the second work package (WP2) and summarized in this deliverable.

Therefore, the market study and user demand results from WP1 are clustered into the main customer needs **information, driving experience/pleasure, safety, comfort, cost-efficiency, time-efficiency** and **eco-friendliness**. In order to transfer these needs into applicable, quantitative requirements, the needs are triple-filtered. In the first step, the needs not applicable to L-category vehicles are sorted out. The second step is the feasibility evaluation of the needs within the product development phase. This concerns in particular those technologies not reaching TRL6 level until 2020. Within the last and third step, the OEMs decide, which items can be placed in their products e.g. regarding the target price. Therefore, they respect the user prioritization established by the “weighted mean”.

In addition to the user requirements, the legal regulations and the market are analysed concerning their influence on the vehicle design. The regulation requirements result from the homologation process for the three vehicle types of the EU-LIVE project. The most relevant regulation for the European Union has the number 168/2013 and forms a framework for the development process of all L-class vehicles. Since the performance of the vehicles is mainly defined by the existing market, at least three reference vehicles of each class are explored to reach an optimal product placement with the EU-LIVE L-vehicles. The reference vehicles for the L3e and L5e vehicles were already defined in D1.1 [3]. For the L3e class these are the Peugeot Satelis 125, the Yamaha X-Max 125 and BMW C Evolution and for the L5e class the Peugeot Metropolis 400, the Piaggio MP3 500 and the Quadro4 350. In addition, several L6e, L7e and M1 electric vehicles are analysed. These are the BMW i3, the Citroën C-Zero / Peugeot iOn / Mitsubishi iMieEV, the Nissan Leaf, the Renault Twizy 45 & 80, the Smart fortwo electric and the VW e-up!

These overall vehicle requirements resulting from the legal and market analysis are broken down into the sublevels lower body/chassis, suspension, upper body/interior, powertrain and electrics/electronics (E/E) allowing the corresponding partners and partner departments an easy use of the requirements in their development process.

In the last step of this deliverable, the partners have a look at the manufacturing process of the vehicles e.g. the painting process and derive corresponding manufacturing requirements as well as review / quality management processes.

Keywords: Vehicle requirements, User Needs, Competitor Vehicles

2 OBJECTIVES

The objective of this deliverable is to define the requirements for the three vehicles, which are going to be developed within the EU-LIVE project. There are three fundamental groups of requirements for the project:

Those are on the one hand the requirements related to the user needs identified in the first work package (WP1). Since the requirements resulting from the surveys are in a qualitative form e.g. “a good acceleration”, the partners have converted them into quantitative requirements by applying different filters, which are usable for the design process.

On the other hand, there are the requirements resulting from the technical targets of the project as well as from the existing and future regulations and standards for the project relevant classes of vehicles. The aim is to analyse the homologation regulations as well as the direct reference vehicles to design best of class vehicles in the categories L3e, L5e and L6e.

Beside these product-related requirements, the third task is to identify the relevant manufacturing requirements. These requirements are defined by the industrial partners, which take care of the components and systems within the design process and give important advice for a redesign.

All requirements are broken down into the potential subsystems as mentioned above enable an easy use by the partners.

This deliverable summarizes the work performed in the following two tasks:

T2.1.1 Quantitative vehicle requirements

T2.1.2 Break-down of vehicle requirements (incl. manufacturing requirements)

The results of this deliverable are directly linked to all following work packages, as the requirements are mandatory for the development process of the vehicles.

3 REQUIREMENTS

This chapter describes how the requirements for the three new lightweight vehicles (L-category vehicles, LXe categories) of the EU-LIVE project are determined. The developed vehicles are a two-wheeled all electric L3e vehicle (BEV), a three-wheeled plug-in hybrid L5e vehicle (PHEV) and a four-wheeled all electric L6e vehicle (BEV). The L3e and the L5e vehicles will be developed as real-life demonstrators in technology readiness level six (TRL 6), using the same technology building blocks and demonstrating the benefits of a platform strategy. The L6e vehicle will be designed as a virtual demonstrator showing the full potential in the transferability of the L3e/L5e technology building blocks across different vehicle categories. Its exterior will be designed in an open innovation contest.

Since the requirements for L-category vehicles differ from normal passenger cars (M1 class vehicles), the requirements for the three vehicles need to be determined. For this, the user requirements, product-related requirements as well as the manufacturing requirements are analysed in the following subsections.

3.1 User Requirements

During the development, the product should be challenged by the user needs perspective. Thus in the EU-LIVE project it was decided to take into account the will and wish of users before starting the design of the parts. This helps to include innovative needs and unknown requirements. In order to proceed, a user study was performed [1]. Then, the marketing department of the two OEMs involved within the project selected among the results the ones that should be required for the product.

3.1.1 Results of Work Package 1

The objective of work package 1 was to provide a thorough understanding of user needs towards vehicle concepts such as the L3e and L5e vehicles. Considering today's challenges of continuous urbanisation, target customers were questioned on their current unfulfilled needs. In focus groups at three different European locations, user needs were identified delivering insight into customer requirements in different countries representing target markets of the future L3e, L5e and L6e vehicles. The identified needs serve as crucial input for the subsequent definition of technical specifications of the L3e, L5e and L6e concepts.

In order to verify user needs and derive desired technical requirements for the L3e, L5e and L6e concepts, individual quantitative and qualitative steps of an experience-centred method (see deliverable D1.2, [1]) were applied. First, a gathering of all possible traffic situations was performed in which the new vehicle concepts may be fulfilling certain needs today's vehicles do not fulfil. These situations were then rated according to their relevance for the particular vehicle concepts by the project's consortium in order to select six situations to be discussed with real end-users. These situations were:

- > City drive in adverse weather conditions
- > City drive in severe traffic conditions
- > Parking the vehicle
- > Transportation of small goods
- > Collecting and entering a car sharing vehicle
- > Vehicle requiring service

Following this, focus groups were conducted in which target customers were given a situation and asked what needs, they usually have in such a situation, moreover, what characteristics their vehicle should have in order to deal with the situation in the most satisfying manner. These needs are item descriptions made by the users (cf. Table 1). During the studies, all needs and desired vehicle characteristics suggested by the participants were recorded and the six traffic situations were discussed with the focus groups. Following the discussion of a particular situation, the participants were asked to prioritise their needs and ideas for potential technical specifications of a vehicle fulfilling their needs. These were numbered and each participant was asked to rate each idea in written form with respect to how important it was for them for this particular idea to be realised using a 5-point Likert scale ranging from 'not important at all' to 'very important'. This gave insight into how

relevant each idea suggested by the participants was regarding the new vehicle concepts L3e, L5e and L6e allowing for a well-defined approach.

Three focus groups were conducted at each of the three different European locations, resulting in a total of nine focus groups. Each focus group, consisting of 6-8 participants, discussed two situations in about 2-3 hours each. This means that all six traffic situations were discussed once per location and three times in total.

All needs derived from the items named by participants were further summarised into 'overall needs', merging the data of all situations into one concise set of information.

According to the study the resulting overall customer's needs in today's traffic are:

- > **Information**
 - > Customers desire to be informed about their vehicle as well as the surrounding traffic situation at all times.
- > **Driving experience/pleasure**
 - > Customers desire for a convenient driving experience in all traffic situations.
- > **Safety**
 - > Customers desire themselves and their vehicle to be safe, not only when driving it but also when picking up a car sharing vehicle or leaving the vehicle parked.
- > **Comfort**
 - > Customers want to be comfortable in any given situation.
- > **Cost-efficiency**
 - > Customers want the vehicle itself as well as respective expenses (e.g. parking) to be as cost-efficient as possible.
- > **Time-efficiency**
 - > Customers want to use their time as efficient as possible. This refers not only to the time spent in the vehicle while driving but also the vehicle's time itself when being parked.
- > **Eco-friendliness**
 - > Customers want their vehicle and its parts to be as eco-friendly as possible.

The gained results were transferred into user requirements using three different filters.

3.1.2 Transfer Method

The focus groups were left free to suggest items for overall personal transportation. The results from the user needs study were numerous and not mandatorily linked to the EU-LIVE concepts. Thus, a first step is to delete among the items, those that are not applicable.

For this step, the work was to decide subjectively, which of the defined items could never be fulfilled by L-category vehicles. Some of the requirements are clearly not adapted to the three categories concerned by EU-LIVE – L3e, L5e & L6e – others were adapted to any of the categories.

Table 1 gives some examples to demonstrate how this filter works:

Item suggested	L3e	L5e	L6e	Justification
Vertical parking is possible in order to fit into small parking spaces.	No	No	No	Very compact vehicle already
Rear seats move forward while loading the boot of the vehicle.	No	Yes	No	No rear seats on L3e & L6e
Attachable supporting wheels for single-track vehicles when moving heavy goods.	Yes	No	No	L5e & L6e aren't single track vehicle
The vehicle has a toilet integrated.	No	No	No	Too compact vehicle
The vehicle is capable of using alternative tracks (e.g. rails instead of roads).	No	No	No	Out of scope
The helmet needed by motorcyclists is equipped with wipers.	No	No	No	Out of scope
Ability to change from manual- to automatic transmission.	No	Yes	No	No transmission on L3e & L6e

Table 1: Example of User Needs Filter One

The second step is to evaluate what technologies would be feasible within the product development phase. Hence, among all items, those are deleted for which a technology breakthrough during these products' development planning is needed (vehicles' launches before 2020).

Table 2 gives some example of items not kept after this filter:

Examples of item deleted

Automatic sorting of shopping into different categories (enhancing an easy unloading at home).
The boot compartment adjusts itself automatically to the size of the shopping.
Car without wheels for alternative routing.
Car exits the parking lot autonomously and drives to driver on phone call.
Attachable supporting wheels for single-track vehicles when moving heavy goods.
The vehicle is able to change its colours (e.g. according to mood).

Table 2: Example of User Needs Filter Two

The items left are sorted using the grade obtained in the user needs study according to deliverable D1.2 [1]. The last filter is a "marketing requirements" filter. The OEMs (PSA and PSCO) need to select among the left items, while respecting the prioritization established by the "weighted mean" explained in part 3.1.1, which items they would like to see on their products.

The final list of user needs is established confidentially by marketing decision during the concept fixing, thus, it cannot be published in this deliverable. Moreover, the selected items will be less than TRL6 in June 2018 and will mostly likely not be on the demonstrators. The items affecting the design of the vehicle will be highlighted for the partners involved.

3.2 Product-related Requirements

In addition to user needs the vehicles have to fulfil, product-related requirements resulting from legal and market requirements affect the vehicle design. Hereinafter, these requirements are referred to as regulation requirements (legal requirements, chapter 3.2.1) and design requirements (market requirements, chapter 3.2.2).

Within the European market, there are homologation requirements that guarantee a vehicle's registration in all member states of the European Union as long as it meets the registration requirements. The Regulation (EU) No 168/2013 contains the superior requirements and forms a framework for the development process of all L-class vehicles [2]. In this legal document, Annex 1, 2 and 5 contain the relevant certification rules. Annex 1 contains a list with technical data (dimensions, power output, number of wheels, number of seats, etc.) to classify vehicles into the various L-classes. Annex 2 contains a list of requirements for the purpose of EU vehicle type-approval for all L-categories (L1e - L7e), divided into "environmental and propulsion performance requirements", "vehicle functional safety requirements" and "vehicle construction and general type-approval requirements". Annex 5 defines subordinate standards and test procedures for the requirements of Annex 2. The requirements for the three L-vehicles are derived from Regulation 168 and are described in chapter 3.2.1.

The design requirements on the other hand are mainly determined by the existing market. They are the result of the customers' wishes and requirements (chapter 3.1) as well as a response to the already existing products on the market. The competitors' products affect the requirements for new or redeveloped vehicles in the same way as own products do. The design requirements are therefore, derived from technical data of competitors, customer requirements, already existing development experience and market studies from the manufacturer's own products. The selected reference vehicles and the derived requirements for the three vehicles are described in chapter 3.2.2.

3.2.1 Regulation Requirements

L-category vehicles is the name of a family of light powered vehicles such as powered cycles, two- and three-wheeled mopeds, motorcycles (with and without side cars), tricycles and quadricycles (light and heavy). Those vehicles have to comply with a set of requirements and regulations, in particular the EU regulation No 168/2013, to get a selling authorization in the EU market and allow their use.

This regulation aims to upgrade the European Union's functional safety and environmental requirements for L-category vehicles. It will insure that future vehicles will pollute less and meet the highest safety standards possible. The exhaustive list of requirements for the purposes of EU vehicle type-approval is divided in three parts that can be found in Table 3. Within this table, "IF" means that if some device is integrated, it has to follow the dedicated regulation. Within the regulation, the L5e and the L6e vehicles consist of two subcategories each: the L5e-A and L5e-B as well as the L6e-A and L6e-B. The vehicles of category L5e-A are made for the transportation of passengers, while those of the category L5e-B are made for the transportation of cargo. All lightweight road quads belong to the category L6e-A. The category L6e-B includes all lightweight four-wheel mobiles.

No	Article	Subject	Regulation file	Vehicle Categories				
				L3e	L5e-A	L5e-B	L6e-A	L6e-B
A ENVIRONMENTAL AND PROPULSION PERFORMANCE REQUIREMENTS								
1	23 & 24	environmental test procedures related to exhaust emissions, evaporative emissions, greenhouse gas emissions, fuel consumption and reference fuels	Regulation 134/2014	X	X	X	X	X
2		maximum design vehicle speed, maximum torque, maximum continuous total engine power of propulsion		X	X	X	X	X
3		test procedures related to sound		X	X	X	X	X
B VEHICLE FUNCTIONAL SAFETY REQUIREMENTS								
1	22	audible warning devices	Regulation 3/2014	X	X	X	X	X
2		braking, including anti-lock and combined brake systems		X	X	X	X	X
3		electrical safety		X	X	X	X	X
4		manufacturer declaration requirements regarding endurance testing of functional safety systems, parts and equipment		X	X	X	X	X
5		front and rear protective structure		-	IF	IF	X	IF

No	Article	Subject	Regulation file	Vehicle Categories				
				L3e	L5e-A	L5e-B	L6e-A	L6e-B
B VEHICLE FUNCTIONAL SAFETY REQUIREMENTS								
6		glazing, windscreen wipers and washers, defrosting and demisting devices		-	IF	IF	X	IF
7		driver-operated controls including identification of controls, tell-tales and indicators		X	X	X	X	X
8		installation of lighting and light signalling devices, including automatic switching-on of lighting		X	X	X	X	X
9		rearward visibility		X	X	X	X	X
10		rollover protective structure (ROPS)		-	-	-	-	-
11		safety belt anchorages and safety belts		-	-	X	IF	IF
12		seating position (saddles and seats)		X	X	X	X	X
13		steerability, cornering properties and turn-ability		X	X	X	X	X
14		installation of tyres		X	X	X	X	X
15		vehicle maximum speed limitation plate and location on vehicle		-	-	IF	IF	IF
16		vehicle occupant protection, including interior fittings, head restraint and vehicle doors		-	IF	IF	IF	IF
17		maximum continuous rated or net power and/or vehicle speed limitation by design		-	-	-	X	X
18		vehicle structure integrity		X	X	X	X	X
C VEHICLE CONSTRUCTION AND GENERAL TYPE-APPROVAL REQUIREMENTS								
1	20	anti-tampering measures		X	X	X	X	X
2	25	arrangements for type-approval procedures		X	X	X	X	X
3	33	conformity of production requirements		X	X	X	X	X
4	18	coupling devices and attachments	Regulation 44/2014	IF	IF	IF	IF	IF
5		devices to prevent unauthorised use		X	X	X	X	X
6		electromagnetic compatibility (EMC)		X	X	X	X	X
7		external projections		X	X	X	X	X
8		fuel storage		IF	IF	IF	IF	IF
9		load platforms		-	-	X	-	IF
10		masses and dimensions		X	X	X	X	X
11	21	on-board diagnostics		X	X	X	X	X
12	18	passenger handholds and footrests		IF	IF	IF	X	
13		registration plate space		X	X	X	X	X
14		repair and maintenance information		X	X	X	X	X
15		stands		X	-	-	-	-

Table 3: Exhaustive List of Regulation Requirements

Brembo, Continental, PSA and PSCO take into account the type-approval requirements for those three concepts. They evaluate the corresponding regulation documents if the requirement is relevant regarding the conception of the components or system it is in charge of, or if it may affect the global architecture of the concept.

In a first step, the regulations for the L3e and L5e vehicles are analysed to fulfil strictly all the requirements with a view to mass production for early market entry. Secondly, it will be decided if the design is feasible on the demonstrators.

For the L6e vehicle, which will explore a radically new concept, the potential needs for changes to homologation requirements and regulations will be analysed later on.

In addition, a monitoring is carried out by PSCO and their department dedicated to L-category vehicles' homologation (especially for L3e and L5e), in order to notify partners as soon as a new regulation is released.

This allows analysing the shifts between the current regulation and the next regulation (especially for pollutant emissions) and makes sure that the concepts could still get type approval.

The result of the complete analysis is then summarised for the three parts of the EU regulation no. 168/2013.

3.2.1.1 Part A : Environmental and Propulsion Performance Requirements

To get type approval, L-category vehicles have to comply with eight different test types for environmental and propulsion performance requirements, such as for evaporative emissions (fuel vapours), pollution control devices, energy efficiency and sound.

The regulation sets environmental requirements for two stages of emission reductions. The first stage (Euro 4) is mandatory for new types of vehicles as of 1 January 2016. A second step (Euro 5) will apply as of 2020, allowing manufacturers and suppliers to plan for the medium term. The feasibility of the Euro 5 step will need to be confirmed with a study of its potential environmental effects in 2016.

The main relevant requirements for this project, out of the corresponding regulation file 134/2014, are shown in the following table, with information on how and when they can be fulfilled:

Type test	Subject	Vehicle Categories	How?	When?
A	ENVIRONMENTAL AND PROPULSION PERFORMANCE REQUIREMENTS			
I	tailpipe emissions after cold start	L3e BEV		
		L5e PHEV	X	Engine & transmission mapping, after treatment technology choices
		L6e BEV		
II	tailpipe emissions at (increased) idle and free acceleration	L3e BEV		
		L5e PHEV	X	Engine & transmission mapping, after treatment technology choices
		L6e BEV		
III	emissions of crankcase gases	L3e BEV		
		L5e PHEV	X	Engine design done carefully
		L6e BEV		
IV	evaporative emissions	L3e BEV		
		L5e PHEV	X	Engine & transmission mapping, after treatment technology choices
		L6e BEV		

Type test	Subject	Vehicle Categories	How?	When?	
V	durability of pollution-control devices	L3e BEV			
		L5e PHEV	X	Exhaust system done carefully, supplier requirements	Exhaust system development
		L6e BEV			
VI	No test has been defined	L3e BEV			
		L5e PHEV			
		L6e BEV			
VII	CO ₂ emissions, fuel consumption, electric energy consumption and electric range	L3e BEV	X	Fulfil by EU-LIVE project consumption target	Consumption calculation in cycle on bench
		L5e PHEV	X		
		L6e BEV	X		
VIII	OBD environmental tests	L3e BEV			
		L5e PHEV	X	-	-
		L6e BEV			
IX	sound level	L3e BEV			
		L5e PHEV	X	Careful powertrain integration and vehicle design	Measurement to do on final serial vehicle (under min and max SOC conditions for hybrid vehicle)
		L6e BEV			

Table 4: Part A - Environmental and Propulsion Performance Requirements

3.2.1.2 Part B: Vehicle Functional Safety Requirements

Relevant for this part is, that manufacturers shall ensure that vehicles are designed, constructed and assembled, so that the risk of injury to the vehicle occupants and to other road users is minimised.

Manufacturers shall moreover ensure that vehicles, systems, components and separate technical units comply with the relevant requirements set out in Annex II of the regulation.

The regulation lays down safety requirements such as:

- > new motorcycles of more than 125 cm³ must be equipped with an anti-lock braking system;
- > mandatory fitting of an anti-lock brake system, a combined brake system or both on a two-wheeled motorcycle under 125 cm³ is left to the manufacturer's discretion;
- > from July 2014, for visibility purposes, all new types of L-category vehicles must be fitted with a mechanism that automatically turns on the lights; as of 1 January 2016, all existing types of these vehicles must also comply;
- > the mandatory fitting of a differential (which allows wheels on the same axle to turn at different rates) on quads and other types of three- and four-wheeled L-category vehicles to ensure they can turn corners safely.

The main relevant requirements for this part, out of the corresponding regulation file 3/2014, are shown in the following table, including information on how and when they can be fulfilled:

No	Subject	Vehicle Categories	Regulation file linked	How?	When?	
B VEHICLE FUNCTIONAL SAFETY REQUIREMENTS						
1	Audible warning devices	L3e	X	R 28 CEE - ONU	With supplier approved components and prescription of installation (position, support)	Performance tested on final vehicle
		L5e-A	X			
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			
2	Braking, including anti-lock and combined brake systems	L3e	X	R 78 CEE - ONU	ABS	Vehicle development phase
		L5e-A	X		<p>ABS</p> <p>L5e vehicle shall be equipped with:</p> <ul style="list-style-type: none"> - parking brake system, AND - A foot-actuated service brake system which operates on the brakes on all wheels, by way of either: <p>(a) A split service brake system; or</p> <p>(b) A CBS that operates the brakes on all wheels and a secondary brake system, which may be the parking brake system.</p>	
		L5e-B	X		<p>Vehicles that are equipped with an ABS system shall be fitted with a yellow warning lamp.</p>	
		L6e-A	X		<p>The parking brake system shall:</p> <p>(a) Have a control, which is separated from the service brake system control</p> <p>(b) Be held in the locked position by solely mechanical means.</p>	
		L6e-B	X			
3	Electrical safety	L3e	X	R 100 CEE - ONU	Prevent vehicle from moving while charging	Development phase
		L5e-A	X			
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			
4	Manufacturer declaration requirements regarding endurance testing of functional safety systems, parts and equipment	L3e	X		Post development requirements, homologation department material not relevant here	Not applicable
		L5e-A	X			
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			
5	Front and rear protective structures	L3e		R 26 CEE - ONU	Fulfilled as regards to Part C / 7 external projections	CF Part C / 7
		L5e-A	IF			
		L5e-B	IF			
		L6e-A	IF			
		L6e-B	IF			

No	Subject	Vehicle Categories		Regulation file linked	How?	When?	
6	Glazing, windscreen wipers and washers, defrosting and demisting devices	L3e	IF	R 42 CEE - ONU	Washer liquid capacity not less than 1 litre, CAD analysis (windscreen area) and devices integration	Design & development phase	
		L5e-A	IF	R 43 CEE - ONU			
		L5e-B	X	R 17 CEE - ONU	L6e vehicle will only be designed as a virtual prototype with a simplified package plan	-	
		L6e-A	IF	R125 CEE - ONU			
		L6e-B	X	R122 CEE - ONU UE R 1008/2010 UE R 672/2010			
7	Driver-operated controls including identification of controls, tell-tales and indicators	L3e	X	R 60 CEE - ONU	-	-	
		L5e-A	X				
		L5e-B	X	R 121 CEE - ONU			
		L6e-A	X	R 39 CEE - ONU			
		L6e-B	X				
8	Installation of lighting and light signalling devices, including automatic switching-on of lighting	L3e	X	R 53 CEE - ONU	No integration constraints; no shift regarding actual position	Fulfilled	
		L5e-A	X	R 48 CEE - ONU	Supplier requirements and installation requirements (excl. front and rear fog lamps optional)	Vehicle development phase	
		L5e-B	X	R 23 CEE - ONU			
		L6e-A	X	R 91 CEE - ONU			
		L6e-B	X				
9	Rearward visibility	L3e	X	R 81 CEE - ONU	No integration constraints; no shift regarding actual position	Fulfilled	
		L5e-A	X		R46 CEE - ONU	CAD analysis (windscreen area) and device integration	Vehicle design phase
		L5e-B	X			CAD analysis	Virtual design phase
		L6e-A	X				
		L6e-B	X				
10	Rollover protective structure (ROPS)	L3e					
		L5e-A					
		L5e-B					
		L6e-A					
		L6e-B					
11	Safety belt anchorages and safety belts	L3e			Location and strength of the anchorages	Design & development phase	
		L5e-A	X				
		L5e-B	X				
		L6e-A	IF				
		L6e-B	IF				

No	Subject	Vehicle Categories		Regulation file linked	How?	When?
12	Seating position (saddles and seats)	L3e	X	R 17 CEE - ONU R 16 CEE - ONU R 44 CEE - ONU	Seat height > 540 mm	Design phase
		L5e-A	X		-	
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			
13	Steer-ability, cornering properties and turn-ability	L3e	X		Two tests: Driving around a 24 diameter circle at 6 km/h, leaving a 100 m diameter circle at 50 km/h	Development phase and test on demonstrators
		L5e-A	X		Description of some driving tests in the file	
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			
14	Installation of tyres	L3e	X	R 75 CEE - ONU R 106 CEE - ONU R 54 CEE - ONU	Tyre regimentation; tyre supplier constraints	Not applicable
		L5e-A	X			
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			
15	Vehicle maximum speed limitation plate and location on vehicle	L3e		R 104 CEE - ONU		
		L5e-A				
		L5e-B	IF			
		L6e-A	IF			
		L6e-B	IF			
16	Vehicle occupant protection, including interior fittings, head restraint and vehicle doors	L3e		R 17 CEE - ONU	Requirements for contactable edges (interior shape radius), door hinges	Design & development Phase
		L5e-A	IF			
		L5e-B	IF			
		L6e-A	IF			
		L6e-B	IF			
17	Maximum continuous rated or net power and/or vehicle speed limitation by design	L3e				
		L5e-A				
		L5e-B				
		L6e-A	X		L6e vehicle will only be designed as a virtual prototype with a simplified package plan	
		L6e-B	X			
18	Vehicle structure integrity	L3e	X		Specific analysis of vehicle structure (calculation report)	In design phase
		L5e-A	X			
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			

Table 5: Part B - Vehicle Functional Safety Requirements

3.2.1.3 Part C: Vehicle Construction and General Type-approval Requirements

The main relevant requirements for “Part C: vehicle construction and general type-approval requirements” out of the corresponding regulation file 44/2014 are shown in the following table, with information on how and when they can be fulfilled:

No	Subject	Vehicle Categories	Regulation file linked	How?	When?	
C VEHICLE CONSTRUCTION AND GENERAL TYPE-APPROVAL REQUIREMENTS						
1	Anti-tampering measures	L3e	X		Powertrain related; homologation material; needed in a second step	After EU-LIVE project
		L5e-A	X			
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			
2	Arrangements for type-approval procedures	L3e	X		Homologation material; needed in a second step	After EU-LIVE project
		L5e-A	X			
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			
3	conformity of production requirements	L3e	X			
		L5e-A	X			
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			
4	coupling devices and attachments	L3e	IF			
		L5e-A	IF			
		L5e-B	IF			
		L6e-A	IF			
		L6e-B	IF			
5	Devices to prevent unauthorised use	L3e	X	R 18 CEE - ONU R 62 CEE - ONU	Homologation material; needed in a second step	After EU-LIVE project
		L5e-A	X			
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			
6	Electromagnetic compatibility (EMC)	L3e	X	R 10 CEE - ONU	No specific requirement necessary	Not applicable
		L5e-A	X			
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			
7	External projections	L3e	X	R 26 CEE - ONU	As current one on the PSCO L3e	Design phase
		L5e-A	X		CAD analysis of the external shape of the vehicle	
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			

No	Subject	Vehicle Categories		Regulation file linked	How?	When?
8	Fuel storage	L3e	IF		Applying to fuel tank (design and tests)	Design phase and validation on demonstrator
		L5e-A	IF			
		L5e-B	IF			
		L6e-A	IF			
		L6e-B	IF			
9	load platforms	L3e	-			
		L5e-A	-			
		L5e-B	X			
		L6e-A	-			
		L6e-B	IF			
10	Masses and dimensions	L3e	X		Mass of optional equipment limited	Design phase
		L5e-A	X			
		L5e-B	X		Static stability criteria	
		L6e-A	X			
		L6e-B	X			
11	on-board diagnostics	L3e	X		No specific requirement necessary	Not applicable
		L5e-A	X			
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			
12	Passenger handholds and footrests	L3e	IF		As current one on PSCO L3e	Requirement fulfilled
		L5e-A	IF		L5e: passenger needs handholds for no seat belt version	Design Phase
		L5e-B	IF			
		L6e-A	X			
		L6e-B	-			
13	Registration plate space	L3e	X		As current one on PSCO L3e	Req. fulfilled
		L5e-A	X		Design	Design phase
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			
14	Repair and maintenance information	L3e	X		Will be fulfilled on production vehicle	Req. fulfilled
		L5e-A	X			
		L5e-B	X			
		L6e-A	X			
		L6e-B	X			
15	Stands	L3e	X		As current one on the PSCO L3e	Req. fulfilled
		L5e-A	-			
		L5e-B	-			
		L6e-A	-			
		L6e-B	-			

Table 6: Part C - Vehicle Construction and General Type-approval Requirements

3.2.2 Design Requirements

The design requirements for the EU-LIVE L3e, L5e and L6e vehicles are the result of a comparison of technical data of different reference vehicles, the user needs and the demands of the legal requirements of EU Regulation 168/2013. The selected reference vehicles can be divided into three classes: the L3e two-wheeler vehicles, the L5e three- and four-wheeler vehicles and the L6e, L7e and M1 battery-electric four-wheeler vehicles. Unlike the L-classes, the M1-class includes normal passenger cars with no more than nine seats including the driver's seat and describes all current motorised cars.

In this chapter, the selected design requirements of the three new EU-LIVE vehicles will be opposed to the data of the reference vehicles. Furthermore, all technical data is divided into the subsections lower body/chassis, suspension, upper body/interior, powertrain and E/E-specification. The competitors and reference vehicles have already been defined in D1.1 for the L3e and L5e category [3]. For the L6e vehicle, a battery electric powered four-wheeler as well as several L6e, L7e and M1 cars that were defined for the L5e vehicle can be used as well.

Because of the on-going development process for the three new vehicles, some of the requirements are confidential and therefore not included in this public deliverable. Some other data is marked with a tilde (“~”) which indicates to a rough value and otherwise had to be left out because of confidentiality as well.

An important part of the EU-LIVE project is the development of the modular powertrain for the L3e, L5e and L6e vehicles. This development process and its results are part of Deliverable 2.2 [6].

EU-LIVE L3e two-wheeler vehicle

The target within the development of the L3e vehicle is to integrate the EU-LIVE modular powertrain into a conventional scooter. Therefore, the technical characteristics of the EU-LIVE L3e vehicle are the result of its conversion from an internal combustion engine to a battery electric vehicle. To ensure that the new BEV is competitive to conventional and battery powered scooters, the target values for energy efficiency and driving performance has to surpass the class average. This ensures that the new battery electric L3e vehicle outperforms the combustion engine driven scooters.

The products selected as reference vehicles for the new L3e two-wheeler are:

- > Peugeot Satelis 125: main competitor of the Yamaha X-Max
- > Yamaha X-Max 125: best-seller of the GT Category in L3e - 125 cc [4]
- > BMW C Evolution (equivalence: 125 cc), best-seller of L3e BEV scooter in France and Spain [4]

The Peugeot Satelis 125 and Yamaha X-Max, both with conventional powertrain (ICE), are chosen as general references for the L3e vehicle category. The BMW C Evolution serves as a specific benchmark vehicle with an electric powertrain (BEV). The technical data of the new EU-LIVE L3e vehicle and its future competitors are listed in Table 7 to Table 11.

	EU-LIVE L3e	Peugeot Satelis 125	Yamaha X-Max 125	BMW C Evo
Lower body/chassis				
Kerb mass [kg]	250	160	169/ABS: 173	265
Total load capacity [kg]	150	190	189	180
Vehicle length [m]	~ 2.3	2.152	2.160	2.190
Vehicle width [m]	~ 0.8	0.765	0.79	0.947
Vehicle height [m]	-	1.425	1.385	1.301

Table 7: Lower Body/Chassis Data of the L3e Vehicles

	EU-LIVE L3e	Peugeot Satelis 125	Yamaha X-Max 125	BMW C Evo
Suspension				
Wheelbase [mm]	1500	1500	1525	1594
Front track [mm]	NA	-	-	-
Rear track [mm]	NA	-	-	-
Numbers of wheels	2	2	2	2
Tire and wheel dimensions	120/70R14 front 130/60R13 rear	120/70R14 front 130/60R13 rear	120/70R15 front 140/70R14 rear	120/70R15 front 160/60R15 rear
Steering system	Handlebar	Handlebar	Handlebar	Handlebar
Manoeuvrability (turning circle) [m]	5 m curb to curb	-	3.6 m	-

Table 8: Suspension Data of the L3e Vehicles

	EU-LIVE L3e	Peugeot Satelis 125	Yamaha X-Max 125	BMW C Evo
Upper body/interior				
Number of rows	1 + 1	2	2	2
No. of occupants (by row)	1	1	1	1
No. of front (lateral) doors	NA	0	0	0
No of rear (lateral) doors	NA	0	0	0
Driver visibility	NA	-	-	-
Using a child seat	NA	NA	NA	NA
Storage spaces / trunk	2 helmets	Box for two helmets, glove compartment with 12V charger	Helmed box for two helmets, glove compartment	Single helmed box under the rear seat
Visibility in the rain	NA	NA	NA	NA
Performance of defroster/demister	NA	NA	NA	NA
Protection against theft and aggression	Handlebar locking, electronic key	-	Steering lock	Steering lock

Table 9: Upper Body/Interior Data of the L3e Vehicles

	EU-LIVE L3e	Peugeot Satelis 125	Yamaha X-Max 125	BMW C Evo
Powertrain/driving performance (ICE/ZEV/PHEV modes)				
Powertrain	BEV	MD13LI4S LFE (liquid) mono cylinder 125cc	Single-cylinder LC 4 strokes 124cc	Permanently excited three-phase-synchronous motor
Driven axle	Rear	Rear	Rear	Rear
Maximum speed (km/h)	110 km/h (ZEV, 1P) 90 km/h (ZEV, 2P, slope 4%)	108	117	120 (restricted)
Starting in reverse gear	NA	NA	NA	NA
Standardised fuel economy	NA	3.6 l/100km	3.2 l/100km	-
Total range (ICE + electric)	-	300	390	100
ZEV range	100km	-	-	100
Noise emitted by the vehicle, from the outside	According to regulation	-	-	-

Table 10: Powertrain/Driving Performance Data of the L3e Vehicles

	EU-LIVE L3e	Peugeot Satelis 125	Yamaha X-Max 125	BMW C Evo
Electric/electronic				
Headlights	NA	NA	NA	NA
Driver assistance systems	ABS	Optional SBC/ABS	Optional ABS	ABS

Table 11: Electric/Electronic Data of the L3e Vehicles

EU-LIVE L5e three-wheeler vehicle

Currently, there are hardly any vehicles in the L5e category with alternative powertrains available on the market. No direct competitor with a serial PHEV or BEV L5e vehicle is currently available for the L5e category. The Peugeot Metropolis and the Piaggio MP3, both with conventional engines, are the most common vehicles in this market segment. The Quadro 4 is a new product in this segment, also with an ICE.

As there are no direct competitors for the L5e EU-LIVE concept, the radically new vehicle has not only to outperform existing three-wheel scooters, but also to perform as “best in class”. This ensures that future customers can draw comparisons between other light L5e vehicles, which may be newly developed in the future, and the EU-LIVE concept. While current L5e vehicles are designed as scooters without a roof, the EU-LIVE three-wheeler will feature amongst other things a closed cabin with doors. Then, it does not only provide

an all-weather and all-year usability, which is an advantage for the user over conventional scooters, but may also be compared to L7e and M1 vehicles.

In this paragraph, the technical data of the EU-LIVE L5e vehicle will be opposed to current L5e vehicles. A comparison to L6e/L7e and M1 cars will be done in the next subchapter. For the L5e category, the following products were selected:

- > Peugeot Metropolis 400: competitor of the MP3, the one the most data is available since it is a vehicle of a consortium member
- > Piaggio MP3 500: best-seller of the L5e segment [4]
- > Quadro 4 350: new concept with 4 wheels that is certified as L5e

All technical data of the L5e vehicles is listed in Table 12 to Table 16:

	EU-LIVE L5e	Peugeot Metropolis 400	Piaggio MP3 LT 500	Quadro 4
Lower body/chassis				
Kerb mass [kg]	~ 400	256	280	279
Total load capacity [kg]	~ 200 (2P + options + load)	190	180	221
Vehicle length [m]	2.400	2.152	2.205	2.180
Vehicle width [m]	0.850	0.775	0.775	1.340
Vehicle height [m]	1.500	1.450	1.405-1.460	1.340

Table 12: Lower Body/Chassis Data of the L5e Vehicles

	EU-LIVE L5e	Peugeot Metropolis 400	Piaggio MP3 LT 500	Quadro 4
Suspension				
Wheelbase [mm]	< 1850	1500	1550	-
Front track [mm]	< 850	465	465	550
Rear track [mm]	< 460	-	-	450
Numbers of wheels	4	3	3	4
Tire and wheel dimensions	motorcycle tire section	120/70R12 front 140/70R14 rear	110/70R13 front 140/70R14 rear	110/80R14 front 110/80R14 rear
Steering system	Handlebar	Handlebar	Handlebar	Handlebar
Manoeuvrability (turning circle) [m]	7-7.3 curb to curb, at less than 5km/h (resulting value for outer contour)	-	-	-

Table 13: Suspension Data of the L5e Vehicles

	EU-LIVE L5e	Peugeot Metropolis 400	Piaggio MP3 LT 500	Quadro 4
Upper body/interior				
Number of rows	2	2	2	2
No. of occupants (by row)	1	1	1	1
No. of front (lateral) doors	2	0	0	0
No. of rear (lateral) doors	0	0	0	0
Driver visibility	Automobile technical feedback	-	-	-
Using a child seat (installing a seat and seating a child)	Yes (with a specific seat instead of the rear seat)	-	-	-
Storage spaces / trunk	2P 1 cabin luggage + 1 front storage compartment 0.5L (electronic lock) 1P rear space modularity	Single small helmet box under the rear seat, access via rear door and seat cover	Double helmet box under the rear seat (65 litres)	Helmet box for one helmet
Visibility in the rain	According to regulation	-	-	-
Performance of defroster/demister	According to regulation	-	-	-
Protection against theft and aggression	Handlebar locking, electronic key	-	-	-

Table 14: Upper Body/Interior Data of the L5e Vehicles

	EU-LIVE L5e	Peugeot Metropolis 400	Piaggio MP3 LT 500	Quadro 4
Powertrain/driving performance (ICE/ZEV/PHEV modes)				
Powertrain	PHEV	Single cylinder 400cc	Single cylinder 493cc	Single cylinder 346cc
Driven axle	Rear	Rear	Rear	Rear
Maximum speed (km/h)	130km/h (ICE, 1P) > 90km/h (ICE, 2P, slope 4%) 70km/h (ZEV, 1P) > 50km/h (ZEV, 2P, slope 4%)	135	142	138
Starting in reverse gear	Electric reverse accepted with roll locked and vehicle speed < 5km/h	-	-	-
Standardised fuel economy (WMTC2.2)	2.6l/100km with optimal energy management strategy	-	-	-
Total range (ICE + electric)	300km	-	-	~ 400
ZEV range	25km	-	-	-
Noise emitted by the vehicle, from the outside	According to regulation	-	-	-

Table 15: Powertrain/Driving Performance Data of the L5e Vehicles

	EU-LIVE L5e	Peugeot Metropolis 400	Piaggio MP3 LT 500	Quadro 4
Electric/electronic				
Headlights	According to regulation	NA	NA	NA
Driver assistance systems	ABS	ABS, manual tilt control	Continental ABS and ASR, manual tilt control	No ABS, combined braking

Table 16: Electric/Electronic Data of the L5e Vehicles

EU-LIVE L5e and L6e vehicle

In this paragraph, the technical data of the EU-LIVE L5e (and L6e) vehicle is opposed to L6e/L7e and M1 vehicles. Two key elements of the EU-LIVE L5e vehicle are its plug-in hybrid powertrain and its closed cabin. Because of these two features, which have not yet been implemented into any series production L5e vehicle, future customers will most likely see the EU-LIVE vehicle as an alternative to a small city car and therefore compare it to those. This will probably be done regardless of the fact that the targeted price range for the L5e vehicles will be different to normal passenger cars.

Within the EU-LIVE project, the L5e PHE vehicle lifetime planned is 120,000 km. However, for the BEV it is 80,000 km.

To withstand the comparison to small M1 city cars and to support the “best in class” L5e entitlement, the EU-LIVE L5e vehicle will feature driver assistance as well as active and passive safety systems and infotainment. With a good turning circle, its ability for transversal parking and local emission free driving, it will be perfectly usable in city centres. Its top speed of 130 km/h, the combination of internal combustion engine and electric engine and its good fuel economy enables its use as a daily commuter car, even on motorways.

Along with the L3e and L5e vehicles, the EU-LIVE project will also develop a virtual L6e prototype. Whereas the technical requirements for the L3e and L5e vehicles are already fixed, some of the L6e vehicle requirements still have to be defined. The wheelbase as well as the front and the rear track will be fixed after the design contest will have been finished and the package model and the exterior design will have been matched. Other dimensional characteristics and architectural features are almost exclusively the result of Regulation 168/2013 and not of the research or comparison to the reference vehicles.

As reference for the EU-LIVE L5e vehicle development, the consortium has selected several battery electric cars of the L6e/L7e and M1 segment. The most established BEVs are the Citroen C-Zero, which is identical with the Mitsubishi iMiEV and the Peugeot iOn, and the Nissan Leaf. BMW targets this segment with the i3, Daimler with its electrified version of the Smart and VW with the e-up!.

Besides these M1 cars, the Renault Twizy is the only serial production battery electric vehicle in the L6e and L7e segment that reaches an interesting number of sales. Since its introduction in 2012, 15,000 Twizy were sold worldwide until April 2015 [5]. This vehicle is the one closest to the EU-LIVE L5e and L6e vehicles concerning vehicle class and vehicle layout. The Renault Twizy is a 2-seated full electric quadricycle, available in a 45 km/h version and a 80 km/h version (L7e vehicle version). The vehicle can be bought as an open version, which means without side windows, or as a closed version. In 2014, a 1-seater cargo version of the Twizy was introduced as well. Apparently, Renault expects market potential for this kind of L-category vehicle in the logistics and cargo segment.

The main difference between the L6e category and the L7e/M1 category is the stricter limitations in power and top speed of the L6e class. L6e vehicles are limited to a top speed of 45 km/h and a continuous power output of 4 kW (L6e-A) or 6 kW (L6e-B) [2]. Therefore, the usability of vehicles from the L7e- and M1-class as a reference is limited. The only exception is the Renault Twizy mentioned before. Since the L6e vehicle is no substitute for M1 cars, there is no risk that it will be compared with those. The vehicle will therefore be designed as a cost effective complement to existing mobility concepts.

The technical data of the EU-LIVE L5e and L6e vehicles as well as the reference L6e/L7e and M1 vehicles is listed in Table 17 to Table 21:

	EU-LIVE L5e	EU-LIVE L6e	BMW i3	Citroen C-Zero	Nissan Leaf	Renault Twizy 45/80	Smart fortwo electric	VW e-up!
Lower body/chassis								
Kerb mass [kg]	~ 400	< 425	1195	1140 - 1156	1505 - 1579	548 / 562	975	1224
Total load capacity [kg]	~ 200 (2P + options + load)	2P + options + load	425	265	367 - 440	137 / 128	175	361
Vehicle length [m]	2.400	< 2.500	3.999	3.395	4.445	2.335	2.695	3.540
Vehicle width [m]	0.850	< 1.500	1.775	1.475	1.770	1.191	1.559	1.645
Vehicle height [m]	1.500	< 1.900	1.578	1.610	1.550	1.480	1.565	1.492

Table 17: Lower Body/Chassis Data of the L5e, L6e, L7e and M1 Vehicles

	EU-LIVE L5e	EU-LIVE L6e	BMW i3	Citroen C-Zero	Nissan Leaf	Renault Twizy 45/80	Smart fortwo electric	VW e-up!
Suspension								
Wheelbase [mm]	< 1850	TBD	2570	2550	2700	1686	1867	2421
Front track [mm]	< 850	TBD	1571	1310	1540	1094	1283	1428
Rear track [mm]	< 460	TBD	1576	1270	1535	1080	1385	1424
Numbers of wheels	4	4	4	4	4	4	4	4
Tire and wheel dimensions	Motorcycle tire section	Automobile tire section	155/70R19	145/65R15 175/55R15	205/55R16	125/80R13 145/80R13	155/60R15 175/55R15	165/65R15
Steering system	Handlebar	Steering wheel / handlebar	Steering wheel	Steering wheel	Steering wheel	Steering wheel	Steering wheel	Steering wheel
Manoeuvrability (turning circle) [m]	7-7.3 curb to curb, at less than 5km/h (resulting value for outer contour)	< 7.00m curb to curb (resulting value, for outer contour)	9.86	9 m (curb to curb)	10.4	6.8	8.75	9.9

Table 18: Suspension Data of the L5e, L6e, L7e and M1 Vehicles

	EU-LIVE L5e	EU-LIVE L6e	BMW i3	Citroen C-Zero	Nissan Leaf	Renault Twizy 45/80	Smart fortwo electric	VW e-up!
Upper body/interior								
Number of rows	2	TBD	2	2	2	2	1	2
No. of occupants	1	TBD	2	2	2	1 + 1	2	2
No. of front doors	2	TBD	2	2	2	2	2	2
No. of rear doors	0	TBD	2	2	2	0	0	2
Driver visibility	Automobile technical feedback		-	-	-	-	-	-
Using a child seat (installing a seat and seating a child)	Yes (with a specific seat instead of the rear seat)	Yes	ISOFIX	ISOFIX	ISOFIX	Yes	ISOFIX	ISOFIX
Storage spaces / trunk	2P 1 cabin luggage + 1 front storage compartment 0.5L (electronic lock)	2P cabin luggage + storage compartment	260-1100	150 - 882	370 - 720		220-340	250-923
Visibility in the rain	According to regulation	According to regulation	-	-	-	-	-	-
Performance of defroster/demister	According to regulation	According to regulation	-	-	-	-	-	-
Protection against theft and aggression	Handlebar locking, electronic key	Steering wheel locking, electronic key	Central locking	Steering wheel locking, electronic key	Electronic key, central locking	Alarm system, electronic immobilizer,	Steering wheel locking, central locking, electronic	Immobilizer

Table 19: Upper Body/Interior Data of the L5e, L6e, L7e and M1 Vehicles

	EU-LIVE L5e	EU-LIVE L6e	BMW i3	Citroen C-Zero	Nissan Leaf	Renault Twizy 45/80	Smart fortwo electric	VW e-up!
Powertrain/driving performance (ICE/ZEV/PHEV modes)								
Powertrain	PHEV	BEV	BEV or Hybrid	BEV	BEV	BEV	Permanent-Magnet-Motor	PSM
Driven axle	Rear	TBD	Rear	Rear	Front	Rear	Rear	Front
Maximum speed (km/h)	130km/h (ICE, 1P) > 90km/h (ICE, 2P, slope 4%) 70km/h (ZEV, 1P) > 50km/h (ZEV, 2P, slope 4%)	< 45km/h	150	130	144	45 / 80	125	130
Starting in reverse gear	Electric reverse accepted with roll locked and vehicle speed < 5km/h	-	-	-	-	-	-	-
Standardised fuel economy (WMTC2.2)	2.6l/100km with optimal energy management strategy	NA	-	-	-	-	-	-
total range (ICE + electric)	300 km	NA	190 (Hybrid)	-	-	-	-	-
ZEV range	25 km	TBD	160	160/100	121-200	120 / 100	145	120-160
Noise emitted by the vehicle	According to regulation	According to regulation	-	-	-	-	-	-

Table 20: Powertrain/Driving Performance Data of the L5e, L6e, L7e and M1 Vehicles

	EU-LIVE L5e	EU-LIVE L6e	BMW i3	Citroen C-Zero	Nissan Leaf	Renault Twizy 45/80	Smart fortwo electric	VW e-up!
Electric/electronic								
Headlights	According to regulation	According to regulation	-	-	-	-	-	-
Driver assistance systems	ABS	ABS	ABS, ESC	ABS, ESC	ABS, ESC	-	ABS, ESC	ABS, ASR, EBV & MSR

Table 21: Electric/Electronic Data of the L5e, L6e, L7e and M1 Vehicles

3.3 Manufacturing Requirements

At the current state of the project there are no manufacturing requirements known, since the vehicles are still in the design phase. After the design phase the manufacturing tools of the vehicle parts will be chosen, which is mandatory for deriving the manufacturing requirements. These requirements will be included in later deliverables of the project.

Nevertheless, in Peugeot Scooters there is a process during design and development to limit issues in the manufacturing process. To sum up, there are three important verifications:

- > Painting review

This verification obviously concerns only painted parts. Painting experts from the industrial field meet the designers in front of CAD models to check if these parts are paintable. They point out every possible difficulty and discuss on each evolution of the painted components. On some components, there are many steps of technical and graphic design necessary. Therefore, the painting review occurs three or four times during the whole design and development phase. When the prototyping phase is going on, the experts check the finish on components.

- > Assembling condition studies

These studies concern those components mounted in the assembly plant. Experts from the industrial fields meet the technical designers and check, first on CAD, that the components will be easy and cheap to assemble. The experts check, which tools will be necessary, how the vehicle/engine must be positioned and how long the assembly will take. In addition, the experts evaluate the additional assembling costs, and accept or modify the components if needed. During the first prototyping phase, they verify their estimation and ask or not for last modifications.

- > Assembling failure modes, effects and criticality analysis

These studies concern the components mounted in the assembly plant. Experts from all fields (technical, industrial, purchasing...) meet. For each mounted component, the experts discuss which issues could arise during the assembly process (e.g. wrong side, tightening torque too low...). They grade each failure and discuss the effect, the frequency and the criticality. Each failure gets a global grade and a minimum grade to respect. For not respected failures, a verification process is set up.

As a result of the above-mentioned process, there are no clear requirements, but there is a complete follow-up of the development with respect to the manufacturing.

Regarding the EU-LIVE project, this process does not have to be followed exactly. It may be necessary to include some verification during the development phase.

4 DISSEMINATION, EXPLOITATION AND STANDARDISATION

The dissemination is primarily achieved by the publication of this deliverable on the EU-LIVE website.

Furthermore, the content of deliverable D2.1 and D2.2 [6] is the basis for the further development of the three vehicles. The development processes of the work packages 4 and 5 make direct use of the results of both deliverables.

The overall L6e vehicle design and the design contest will be part of deliverable D4.3. Both deliverables together will be the basis for further publications. Based on the concept development of the L6e vehicle and the virtual package model, further investigations on the vehicle concept can be made. The results may be published in the form of diploma theses, scientific publications and presentations or a dissertation.

The findings from the modular drive train concept as well as the results of the L-category vehicle development itself can be further used in other scientific and industrial projects. The results of the EU-LIVE project cannot be used only for future vehicle concepts but for broader urban mobility concepts as well.

5 CONCLUSION

The aim of task 2.1 was to generate a technical backbone for each of the three new EU-LIVE L-category vehicles on which the further technical development can build on. Therefore, the identified requirements were split into three fundamental groups:

- > the requirements related to the user needs
- > the legal and design requirements
- > and the manufacturing requirements

Outgoing from the user needs identified in the first work package (WP1), the so-called user requirements resulting from surveys of the focus groups were categorised into the overall needs information, driving experience/pleasure, safety, comfort, cost-efficiency, time-efficiency and eco-friendliness (see section 3.1.1). The qualitative results from the surveys were transferred into tangible data. This transfer was explained in section 3.1.2. The final decision which items were carried over to the final design is confidential to marketing decisions. Thus, the final list of user requirements was not published within this deliverable.

The product-related requirements resulted from the legal and the market side. These requirements were referred to as regulation requirements (chapter 3.2.1) and design requirements (chapter 3.2.2).

All the corresponding legal regulation documents were identified for relevant requirements regarding the concept design of single components, the system or possible impacts on the global architecture of the concept. This was for the evaporative emissions (fuel vapours), pollution control devices, energy efficiency and sound the regulation file 134/2014. For the vehicle functional safety, the regulation 3/2014 had to be taken into account, which e.g. says that motorcycles with more than 125 cm³ must be equipped with an anti-lock braking system. The vehicle construction and general type-approval requirements were found in the regulation 44/2014. In addition to the already existing regulations, the consortium will track future regulations and updates during the design phase.

For the design requirements, a defined number of reference vehicles of the different L-classes and the M1-class were analysed. The results of this analysis and the effects of the regulation requirements led to the design requirements for the three new EU-LIVE vehicles.

The technical characteristics of the L3e vehicle were the result of its conversion from an internal combustion engine to a battery electric vehicle. The target values for energy efficiency and driving performance surpass the class average, which ensures that the new battery electric L3e vehicle outperforms the combustion engine driven scooters in its class. In contrast to the competitors, the EU-LIVE L3e vehicle will not have two rows. It will be a 1+1 seat offering the driver more comfort without losing the potential to carry another passenger.

As there are no direct competitors for the L5e EU-LIVE concept, the radically new vehicle has not only to outperform existing three wheeler scooters but also to perform as "best in class". This is the only way to ensure that future customers can draw comparisons between regular M1 cars, future L5e, L7e vehicles and the EU-LIVE vehicle and see this as an actual alternative to a small city car. Therefore, it will feature driver assistance as well as active and passive safety systems and infotainment as in smaller M1 cars. However, with a good turning circle, its ability for transversal parking and local emission free driving, it will be more usable in city centres. A top speed of 130 km/h, the combination of internal combustion engine and electric engine and good fuel economy will enable its use as a daily commuter car, even on motorways. The consortium aims to maximise the wheelbase (<1850 mm) offering a stability to the driver. As another highlight, the L5e-vehicle will be equipped with doors. This measure aims again to increase the comfort and to motivate the customers to change from M-class vehicles to smaller urban vehicles.

Most of the dimensional characteristics and architectural features for the L6e vehicle are the result of Regulation 168/2013 and not of comparison to other vehicles. Some data has not been defined yet and will be fixed after the design contest is finished and the package model and the exterior design have been matched. The L6e vehicle will be only designed as a virtual demonstrator. It will show the full potential in the transferability of the L3e/L5e technology building blocks across different vehicle categories. Therefore, its CAD-model will not have to match all the regulation requirements (e.g. glazing, windscreen wipers and washers, defrosting and demisting devices) but show the potential of the EU-LIVE development approach. All requirements for the three vehicles can be found in the appendix (see chapter A)

The last aspect taken into account was the manufacturing requirements, which were not definable at this early state of the project and will be included in future deliverables. Nevertheless, Peugeot Scooters supposed the three verifications; painting review, assembling condition studies and the assembling failure modes.

6 REFERENCES

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- [3] EU-LIVE Deliverable D1.1 “Market studies synthesis (L5e and L3e) incl. defined target groups”, V1.0, 2015-10-30
- [4] European Vehicle market statistics, Pocketbook 2014, icct, International Council on Clean Transportation Europe, <http://eupocketbook.theicct.org>, (last accessed, 2015-10-05)
- [5] AutoVolt Magazine, <http://www.autovolt-magazine.com/>, (last accessed, 2016-01-26)
- [6] EU-LIVE Deliverable D2.2 “Modular powertrain requirements”, v1.0, 2016-02-26

A. APPENDIX

User Requirements

RQ_ID	Rationale	Requirement Description	Priority	Vehicle
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Confidential

Regulation Requirements

RQ_ID	Rationale	Requirement Description	Priority	Vehicle
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Reg_01	Environmental	Tailpipe emissions after cold start	Have to be fulfilled	L5e
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Reg_02	Environmental	Tailpipe emissions at idle and free acceleration	Have to be fulfilled	L5e
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Reg_03	Environmental	Emission of crankcase gases	Have to be fulfilled	L5e
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Reg_04	Environmental	Evaporative emissions	Have to be fulfilled	L5e
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Reg_05	Environmental	Durability of pollution-control devices	Have to be fulfilled	L5e
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Reg_06	Environmental	CO ₂ emissions, fuel consumption, electric energy consumption and electric range	Have to be fulfilled	All
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Reg_07	Environmental	OBD environmental tests	Have to be fulfilled	L5e
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Reg_08	Environmental	Sound level	Have to be fulfilled	L5e
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Reg_09	Functional safety	Audible warning devices	Have to be fulfilled	All
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Reg_10	Functional safety	Braking, including anti-lock and combined brake systems	Have to be fulfilled	All
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Reg_11	Functional safety	Electrical safety	Have to be fulfilled	All
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Regulation Requirements

RQ_ID	Rationale	Requirement Description	Priority	Vehicle
Reg_12	Functional safety	Manufacturer declaration requirements regarding endurance testing of functional safety systems, parts and equipment	Not applicable	All
Reg_13	Functional safety	Front and rear protective structures	Have to be fulfilled	L5e&L6e IF
Reg_14	Functional safety	Glazing, windscreen wipers and washers, defrosting and demisting devices	Have to be fulfilled	L5e-A&L6e-A IF L5e-B&L6e-B
Reg_15	Functional safety	Driver-operated controls including identification of controls, tell-tales and indicators	Have to be fulfilled	All
Reg_16	Functional safety	Installation of lighting and light signalling devices, including automatic switching-on of lighting	Have to be fulfilled	All
Reg_17	Functional safety	Rearward visibility	Have to be fulfilled	All
Reg_18	Functional safety	Safety belt anchorages and safety belts	Have to be fulfilled	L5e L6e IF
Reg_19	Functional safety	Seating position (saddles and seats)	Have to be fulfilled	All
Reg_20	Functional safety	Steer-ability, cornering properties and turn-ability	Have to be fulfilled	All
Reg_21	Functional safety	Installation of tyres	Not applicable	All
Reg_22	Functional safety	Vehicle occupant protection, including interior fittings, head restraint and vehicle doors	Have to be fulfilled	L5e&L6e IF
Reg_23	Functional safety	Maximum continuous rated or net power and/or vehicle speed limitation by design	Have to be fulfilled	L6e
Reg_24	Functional safety	Vehicle structure integrity	Have to be fulfilled	All
Reg_25	Vehicle construction	Anti-tampering measures	After EU_LIVE project	All
Reg_26	Vehicle construction	Arrangements for type-approval procedures	After EU_LIVE project	All
Reg_27	Vehicle construction	Devices to prevent unauthorised use	After EU_LIVE project	All

Regulation Requirements

RQ_ID	Rationale	Requirement Description	Priority	Vehicle
Reg_28	Vehicle construction	Electromagnetic compatibility (EMC)	Not applicable	All
Reg_29	Vehicle construction	External projections	Have to be fulfilled	All
Reg_30	Vehicle construction	Fuel storage	Have to be fulfilled	L5e
Reg_31	Vehicle construction	Masses and dimensions	Have to be fulfilled	All
Reg_32	Vehicle construction	On-board diagnostics	Not applicable	All
Reg_33	Vehicle construction	Passenger handholds and footrests	Have to be fulfilled	L3e&L5e IF
Reg_34	Vehicle construction	Registration plate space	Have to be fulfilled	L3e&L5e IF
Reg_35	Vehicle construction	Stands	Have to be fulfilled	L3e

Design & Performance Requirements

RQ_ID	Rationale	Requirement Description	L3e	L5e	L6e
DPR_01	Lower body/chassis	Kerb mass [kg]	250	~ 400	< 425
DPR_02	Lower body/chassis	Total load capacity [kg]	150	~ 200	TBD
DPR_03	Lower body/chassis	Vehicle length [m]	~2.3	2.400	< 2.500
DPR_04	Lower body/chassis	Vehicle width [m]	~0.8	0.850	< 1.500
DPR_05	Lower body/chassis	Vehicle height [m]	No requirement	1.500	< 1.900

Design & Performance Requirements

RQ_ID	Rationale	Requirement Description	L3e	L5e	L6e
DPR_06	Suspension	Wheelbase [mm]	1500	< 1.850	TBD
DPR_07	Suspension	Front track [mm]	NA	< 850	TBD
DPR_08	Suspension	Rear track [mm]	NA	< 460	TBD
DPR_09	Suspension	Number of wheels	2	4	4
DPR_10	Suspension	Tire and wheel dimensions	120/70R14 front 130/60R13 rear	Motorcycle tire section	Automobile tire section
DPR_11	Suspension	Steering system	Handlebar	Handlebar	Steering wheel / handlebar
DPR_12	Suspension	Manoeuvrability	5 m curb to curb	7.3 m curb to curb	< 7 m curb to curb
DPR_13	Upper body/interior	Number of rows	1+1	2	TBD
DPR_14	Upper body/interior	No. of occupants by row	1	1	TBD
DPR_15	Upper body/interior	No. of front lateral doors	NA	2	TBD
DPR_16	Upper body/interior	Driver visibility	NA	Automobile technical feedback	Automobile technical feedback
DPR_17	Upper body/interior	Using a child seat	NA	Yes (with a specific seat instead of the rear seat)	Yes
DPR_18	Upper body/interior	Storage Spaces / trunk	2 helmets	2P 1 cabin luggage + 1 front storage compartment 0,5L (electronic lock)	2P 2 cabin luggage + storage compartment
DPR_19	Upper body/interior	Visibility in the rain	NA	According to regulation	According to regulation

Design & Performance Requirements

RQ_ID	Rationale	Requirement Description	L3e	L5e	L6e
DPR_20	Upper body/interior	Performance of defroster/demister	NA	According to regulation	According to regulation
DPR_21	Upper body/interior	Protection against theft and aggression	handlebar locking, electronic key	handlebar locking, electronic key	steering wheel locking, electronic key
DPR_22	Powertrain/driving performance	Powertrain	BEV	PHEV	BEV
DPR_23	Powertrain/driving performance	Driven axle	Rear	Rear	TBD
DPR_24	Powertrain/driving performance	Maximum Speed	110 km/h (ZEV, 1P) 90 km/h (ZEV, 2P, slope 4%)	130km/h (ICE, 1P) > 90km/h (ICE, 2P, slope 4%) 70km/h (ZEV, 1P) > 50km/h (ZEV, 2P, slope 4%)	< 45km/h
DPR_25	Powertrain/driving performance	Starting in reverse gear	NA	Electric reverse accepted with roll locked and vehicle speed < 5km/h	Virtual prototype
DPR_26	Powertrain/driving performance	Standardised fuel economy (WMTC 2.2)	NA	2.6 l/100km	NA
DPR_27	Powertrain/driving performance	Total range (ICE+electric) [km]	NA	300	NA
DPR_28	Powertrain/driving performance	ZEV range [km]	100	25	TBD
DPR_29	Powertrain/driving performance	Noise emitted by the vehicle	According to regulation	According to regulation	According to regulation
DPR_30	Electric/electronic	Headlights	According to regulation	According to regulation	According to regulation
DPR_31	Electric/electronic	Driver assistance systems	ABS	ABS	ABS

Design & Performance Requirements

RQ_ID	Rationale	Requirement Description	L3e	L5e	L6e
DPR_32	Durability	Life time [km]	80,000	120,000	Virtual prototype

Manufacturing Requirements

RQ_ID	Rationale	Requirement Description	L3e	L5e	L6e
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Unknown at the current state of the project, nevertheless three measures are proposed (see chapter 3.3)

B. ABBREVIATIONS AND DEFINITIONS

Term	Definition
ABS	Anti-lock Braking System
BEV	Battery Electric Vehicle
ESC	Electronic Stability Control
ICE	Internal Combustion Engine
ISOFIX	International standard for attachment points for child safety seats
LXe	Light Vehicles (X = different categories)
M1	Passenger cars with a maximum of nine seats, incl. Driver seat
NA	Not Applicable
OBD	On-Board Diagnostics
OEM	Original Equipment Manufacturer
PHEV	Plug-in Hybrid Electric Vehicle
SBC	Sensotronic Brake Control
TBD	To Be Define
TCS	Traction Control System
TRL	Technology Readiness Level
ZEV	Zero Emission Vehicle