Adoption & Policy

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Documentation of Delayed Submission

Planned Date	2024-12-31
Actual Date	2025-07-30
Reasons causing delay	Due to an inconsistency in the preparation of the Grant Agreement, Task 2.5 was shifted to end in M42 but not the related deliverable (D2.3).
Effects on follow-up activities and other WPs/tasks	N/A
Mitigation measures	At this stage, D2.3 would not fully cover all the planned topics and therefore is based mainly on T2.4 output and a first draft of policy guidance. A new deliverable (D2.4) has been introduced to complete T2.5 (as part of the first Amendment) and is planned for M42.

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1. Executive Summary

Deliverable D2.3 provides guidance for fostering mass adoption of frugal Light Electric Vehicle (LEV) solutions and marks a major milestone in the GIANTS project, establishing the foundation for a robust business model aligned with the platform's technological ambitions and market realities. The consortium has defined a reference technological architecture in accordance with the Grant Agreement and conducted a thorough market analysis, including a competitive benchmark and initial cost assessment.

This analysis enabled a segmentation of the platform into Low Power and High Power variants, supporting a more targeted evaluation of economic feasibility. While some partners could not disclose full pricing details due to confidentiality constraints, the aggregated results provide a realistic picture of the platform's cost structure and competitiveness.

Findings show that the current costs remain relatively high, particularly for emerging economies, prompting the consortium to explore cost optimisation strategies. Localised production in regions such as India emerged as a key lever for improving cost competitiveness.

It is important, however, to distinguish these considerations for emerging markets from the commitments made for the EU market. The consortium is committed to pursuing EU-based solutions, aligned with European regulatory and industrial frameworks, wherever possible. Achieving this may require policy, regulatory and financial support to ensure economic viability.

Each partner contributed to the identification of realistic optimisation strategies based on their role and expertise in the value chain. These inputs form the basis for the next steps: refining cost structures, exploring industrial partnerships, and shaping a sustainable business model tailored to both European and international market needs.

The deliverable also highlights the critical importance of public support – particularly from the European Commission – to help cover R&D and capital investment (CAPEX) costs. While the proposed technologies are promising and disruptive, they involve significant upfront investments and dedicated infrastructure, making it difficult to attract sufficient private funding, especially for SMEs.

EU support is therefore essential to reduce risks in key development and industrialisation phases, enabling the emergence of high-impact innovations that might otherwise remain at the concept or demonstrator stage. This funding contributes directly to the EU's strategic priorities on green transition, industrial sovereignty, and innovation acceleration.

In addition to business model development, the deliverable outlines an approach to city engagement and presents an initial set of policy recommendations. These are based on survey insights (as analysed in D2.2), internal expert discussions within the consortium, early stakeholder exchanges, desk research, and existing knowledge. They will be refined further through engagement with cities and key stakeholders as the project progresses and demonstrations unfold.

Keywords: Modular platform, Standardized interfaces, Volumes, Pricing, Business Model, Localisation, Europe

2. Objectives

The GIANTS (Green Intelligent Affordable Nano Transport Solutions) project sets out to develop a new electric vehicle platform that provides frugal (not over-engineered), accessible, modular, and scalable solutions with innovative charging solutions to both emerging and advanced markets.

The objectives for this specific Deliverable, D2.3 is to provide a guidance for fostering mass adoption of frugal LEV solutions targeting market actors and public authorities and to include policy recommendations.

This deliverable D2.3:

- Identifies customer values for frugal vehicles;
- Refines business models for GIANTS platform;
- Develops guidelines for mass adoption of frugal electric vehicles solutions.

Specifically, this content provides the GIANTS platform business model and initial policy recommendations. This will feed into the larger objectives for Work Package 2 (WP2) and final policy recommendations which will be provided in the end of project in D2.4.

The work completed within T2.1, T2.2, and T2.3 provides a foundation for this work, though a user survey which gathered input from a broad demographic, geographic, and economic range of respondents to establish information on user needs and preferences.

From that stage, the objectives of the Deliverable are linked to work within tasks 2.4 (establish and refine business models) and 2.5 (policy recommendations).

Establishing a feasible business model is one of the first concrete steps towards adoption, and this includes cost calculations based on data from product and production costs, as well as target pricing at various production volumes. The tasks include carrying out an analysis of customer value and a market analysis to strategically position the GIANTS solution and aims for the solutions to be frugal and not over-engineered.

These objectives were met within this document which provides comprehensive information on business models (section 3.) and a set of initial policy recommendations (section 4.) which aim to support adoption and acceptance by cities and users.

The process in general so far has advanced cooperation across a range of stakeholders to further develop solutions, increase EU competitiveness, and supports the evolution and understanding on the implementation of such features as solar panels, swappable batteries, and modular features. Frugality has been kept in mind (avoiding over-engineering).

In GIANTS context the frugality is seen as not over-engineered, and ‘cost’ remains a hurdle to refine and lower as possible. If the context is to be operations and production within the EU, while there are less ethical environments and lower wage/productions costs and locations outside of the EU, financially competing may require financial and regulatory support within the EU.

The process of creating the business models included: listing the pain points for customers, users and operators; a business model analysis; GIANTS platform pricing and a framework for pricing; performing a market analysis; and benchmarking the competition at the component and platform level.

Initial policy recommendations were created from the analysis and conclusions drawn from the survey and the work completed in D2.1 and D2.2 and will evolve as the project moves forward through ongoing discussions with stakeholders such as cities, fleet operators and users to support mass adoption and integration into urban mobility ecosystems.

3. Building GIANTS Platform business model, a prerequisite before GIANTS LEV mass adoption

In the context of the GIANTS project, "mass adoption" refers to the successful introduction of new Light Electric Vehicle (LEV) offerings that align with customer needs. Past studies indicate that addressing a broad spectrum of customer profiles and market types – ranging from advanced to emerging economies – requires a diverse range of vehicle categories (L5, L6, L7). Across all these types, ensuring vehicles are affordable and appropriately sized will be essential for widespread uptake.

It is widely accepted that the components such as the e-motor and battery represent up to 46% of the total cost of an electric vehicle (category M1). Data on L-Class vehicles is limited, but extrapolation suggests that this subset accounts for around 40% of the vehicle's cost.

L-Class LEV's affordability and right-sizing will highly rely on price competitiveness and performance of this subset, so called GIANTS platform.

T2.4 aims to establish the most competitive pricing for the GIANTS platform, making it a standard and accessible component for all OEMs regardless of the L-Class LEV they are developing. Section 3 will outline how a sustainable business model can be structured to support the implementation of the GIANTS platform.

3.1 Scope of GIANTS platform

According to the Grant Agreement (GA), the GIANTS platform will be based on the following components:

- Flexible, scalable powertrain with standardised interfaces;
- Standardised vehicle e-control unit;
- Modular, swappable battery;
- Solar panel;
- IoT device;
- Adjustable control and information system.

These joint components will be validated in 11 prototype vehicles produced by four manufacturers in emerging and advanced markets.

Partners involved in T2.4 have agreed on the following System of Interest (SOI), highlighting all the standardised interfaces:

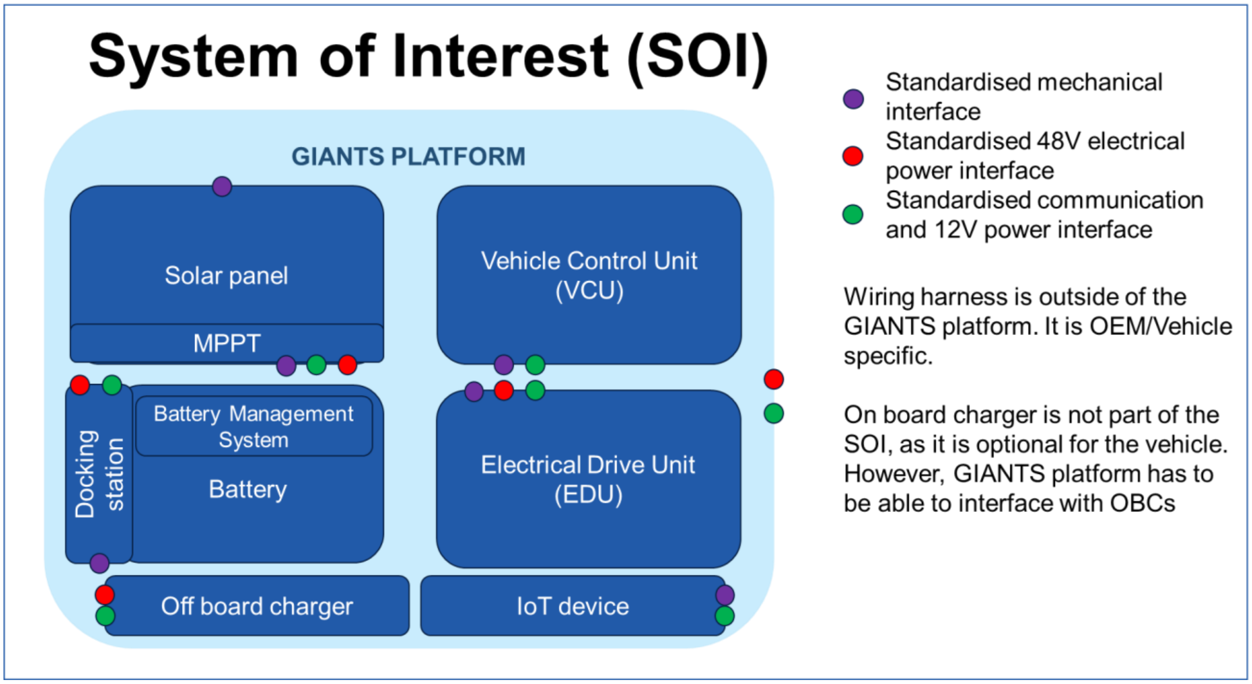

Figure 3-1: Giants platform and its standardised interfaces

3.2 Technical references used for pricing

As a basis for discussion on business models, it was necessary to establish a technical reference in the early stage of Task 2.4. Users' requirements being various, with limited expectations for private usage and higher requirements for some professional and intensive usage, two variants were defined:

- Low power variant mainly for private or non-intensive usages;
- High power variant for professional intensive usages.

Each partner has proposed a definition for each variant based on its own expertise, on already available products, and on competitors' proposals.

Below is the final technical definition with 2 variants used as reference for price discussion:

GIANTS

GIANTS Variants for pricing

Specification	Low Power (LP)	High Power (HP)
Traction power (peak / continuous) [kW]	6 / 9	12 / 18
Traction torque (peak / continuous) [Nm]	300 / 600	600 / 1200
Battery type	14S 10P (2.2kWh)	14S 10P (2.2kWh)
Number of packs	3	6
Solar panel standardized shape	Standard 2D	Standard 2D
Solar panel power density [Wp/m²]	200 (zebra)	200 (zebra)
Solar panel size [m²]	1.5	3
Number of MPPTs	1	2
Solar panel standalone body?	roof delivered by OEM, Solbian does lamination on it & sends back finished product to OEM	roof delivered by OEM, Solbian does lamination on it & sends back finished product to OEM
GPS included	Y	Y
Amount of data exchange per year	1GB	1GB
Server infrastructure included	N	N

Figure 3-2: Description of 2 GIANTS variants used for pricing

Each component for each variant will be detailed in section 3.5.

3.3 Structuring hypotheses for pricing establishment

To establish the pricing for the GIANTS platform, 7 hypotheses (H) have been formulated:

H1. The System of interest comprises:

- As a basis: Vehicle Control Unit, Electrical Drive Unit, Battery packs (BMS included), On-board docking station, Solar panels, MPPT (solar panel DC-DC converter);
- As options: Off-board charging station and IoT device.

H2. Cost assessment is based on 25%, 50% and 100% of the volumes described in the GA.

H3. The success rate hypothesis for VALEO, Solbian & Cleantron is 100%. That means that for these three suppliers the volumes quoted are supposed to be realised.

H4. The selling price shall be uniform for all OEMs, regardless of their size or order volume, with no penalties applied if actual order quantities fall below expectations.

H5. Capital Expenditure (CAPEX) and Research & Development (R&D) costs of each supplier are "diluted" in the overall volumes.

H6. Reference data for labour, energy and raw material cost is available in Q1 2025.

H7. Specific R&D activities related to integration, modification, and testing beyond GIANTS standards are outside the scope.

Among these hypotheses, H4 & H5 are highly structuring:

- H4, assuming that small and large OEMs will be charged with the same price for the GIANTS's platform, regardless of order volumes and without penalties for unmet forecasts, is an unusual practice between OEMs & suppliers. However, this approach was chosen to improve accessibility for small OEMs, encourage the development of a broader product range, promote this type of vehicle, and ultimately accelerate market adoption and growth.

- H5, when combined with the absence of penalties under H4 for unmet volumes, this represents an unusual practice, that is typically beyond the capacity of private suppliers, which will not invest and support the risk in case of no take-off. To enable this, suppliers would require an advance from strategic stakeholders (e.g. European Commission, EU Member States, etc.), which would be reimbursed only if the forecasted volumes are realised (reimbursable advance).

3.4 Volumes assumptions

In the context of the GIANTS platform business model, estimating future sales volumes is essential to assess the platform's cost-reduction potential. The original figures referenced in the Grant Agreement (GA) reflect a progressive ramp-up of GIANTS adoption between 2030 and 2033:

Table 2-2: Projected revenue from exploitation of GIANTS platform

Year after project end	Exploitation of GIANTS platform	Projected overall revenue
1 (2029)	Further development of platform technology and buildup of production capacities within small OEMs manufacturing demo-vehicles, further development of components at component suppliers, further developments for use of GIANTS platform for vehicles produced by large OEMs.	
2 (2030)	28.000 GIANTS vehicles marketed annually by small OEMs, vehicle prototypes based on GIANTS platform/components ready at large OEMs	Small OEMs: 206 Mill €
3 (2031)	45.100 GIANTS vehicles marketed annually by small OEMs, 100.000 vehicles marketed by large OEMs	Small OEMs: 313 Mill. € Large OEMs: 900 Mill. €
4 (2032)	66.000 GIANTS vehicles marketed annually by small OEMs, 500.000 vehicles marketed by large OEMs	Small OEMs: 476 Mill € Large OEMs: 4.500 Mill €
5 (2033)	104.000 GIANTS vehicles marketed annually by small OEMs, 750.000 vehicles marketed by large OEMs	Small OEMs: 747 Mill. € Large OEMs: 6.750 Mill €

In addition to the figures listed in Table 2-2, component suppliers will exploit individual components for use in other vehicles/appliances.

Figure 3-3: Volumes references as described in GA

This volume trajectory results in a cumulative total of approximately **1.6 million units over four years** (period 2030-2033).

This scenario represents an ambitious vision for GIANTS market penetration. It is designed to illustrate the maximum theoretical cost benefits the GIANTS platform could deliver under ideal conditions – where strong adoption, policy support, and industrial alignment (economies of scale) all converge.

However, it is important to recognise that the L-category vehicle segment is still in an early stage of adoption. In Europe, momentum is growing, with early commercial products like the Citroën AMI showcasing the success of compact electric vehicles for urban mobility. Nevertheless, widespread adoption may progress more gradually due to several factors, such as:

- Limited infrastructure;
- Variability in regulatory frameworks across countries;

- Usage restrictions (e.g.: express way not allowed);
- Ongoing consumer acceptance and trust-building.

Unlike traditional passenger vehicles (M-category), which benefit from well-established supply chains and global markets, L-category vehicles are emerging and still defining their role in urban transport ecosystems.

Alternative Volume Scenarios

To reflect different adoption trajectories and provide a **more realistic and flexible analysis**, we propose a **tiered volume model** that complements the original high-growth scenario. This allows us to better understand how production scale could influence cost reduction, pricing, and investment viability.

The proposed cumulative volume scenarios for the 2030–2033 period are:

Scenario	Total Units (2030-2033)	*Small OEMs	*Large OEMs
1. High Adoption (Full Market)	1,600,000	250,000	1,350,000
2. Medium Adoption (Moderate Growth)	800,000	125,000	675,000
3. Low Adoption (Emerging)	400,000	62,500	337,500

Figure 3-4: Scenarios used for GIANTS platform's pricing

** Note: "Small" and "Large" refer to the size of the OEMs, not the vehicle dimensions.*

These scenarios are not forecasts, but **reference points** to:

- Assess how varying production volumes affect unit costs and platform scalability;
- Determine the affordability potential of L-category vehicles across use cases;
- Support strategic planning for both small and large OEMs under different market development paths.

This approach strengthens the overall analysis by balancing ambition with realism, and by acknowledging that the GIANTS platform's success depends not only on technology, but also on market dynamics, policy evolution, and consumer uptake.

3.5 GIANTS platform's pricing results

In GIANTS' platform, the following components: EDU, VCU, Battery, BMS, docking station, solar panel & MPPT are mandatory. Customers cannot dissociate them. VCU is the same for both variants LP & HP. The other components are different for LP variant and HP variant. For confidentiality reason, Valeo, Cleantron and Solbian, suppliers of these components don't want to display their price separately. In the table below, only the sum of these mandatory components, is displayed under the name of **GIANTS Basis total price LP (or HP).**

Off-board charger, as well as IoT device and service, are optional: customers decide by themselves if they want buy these components or not. Prices are displayed separately. The price including these 2 options is displayed **as GIANTS total price LP (or HP) full.**

Giants basis price and Giants full price are displayed in the table below, with both variants LP and HP, and with 3 different volumes scenarios.

Year	2030 - 2033	2030 - 2033	2030 - 2033
Volume Small OEM	62 500	125 000	250 000
Volume Large OEM	337 500	675 000	1 350 000
Total Volume (worldwide)	400 000	800 000	1 600 000
Split Low Power (LP) (70%)	280 000	560 000	1 120 000
Split High Power (HP) (30%)	120 000	240 000	480 000
Price VALEO EDU LP (€)			
Price VALEO EDU HP (€)			
Price VALEO VCU LP/HP (€)			
Price CLEANTRON LP (€)		Confidential	
Price CLEANTRON HP (€)		(only shared between VALEO, CLEANTRON, SOLBIAN)	
Price SOLBIAN LP (€)			
Price SOLBIAN HP (€)			
GIANTS Basis Total price LP (€)	**2825**	**2819**	**2477**
GIANTS Basis Total price HP(€)	**5429**	**5022**	**4740**
Off board charger LP (€) option	348	340	325
Off board charger HP (€) option	696	680	650
HiWi tronics	25 %	50 %	75 %
IoT price (€) option	54.2	47.3	38.1
IoT 4Y service (€) option	40	40	40
GIANTS total price LP full (€)	**3267**	**3046**	**2880**
GIANTS total price HP full (€)	**6219**	**5789**	**5468**

Figure 3-5: GIANTS' platforms pricing in euros (€)

Following our hypothesis H5, CAPEX R&D costs "diluted" in the overall volumes, the total price is decreasing when volumes increase.

- For low-power variant, GIANTS' platform price (basis) varies from to 2477 € to 2825 €
- For high-power variant, price is almost double and varies from 4740 € to 5429 €.

Cost drivers, benchmark competitors and check of consistency are described below for each element of Giant's platform.

3.5.1 Electrical Drive Unit

The Electrical Drive Unit (EDU) represents a core subsystem of the e-Driveline, integrating the electric motor, inverter, and transmission. As such, it is one of the most cost-intensive elements within the overall GIANTS platform architecture.

A detailed breakdown shows that the **main cost drivers** within the EDU are the **key components themselves** – particularly the electric motor, power electronics, and mechanical gearing. These parts involve costly raw materials (e.g., copper, rare-earth magnets, silicon carbide) and precision manufacturing processes.

To mitigate these structural costs, the development and production of the EDU have already been **fully localised in India**, a strategic choice driven by both economic and market-access considerations. This localisation provides significant cost advantages in terms of:

- **Labour costs**, which are considerably lower than in Europe;
- **Supply chain proximity**, reducing logistics and inventory costs;
- **Adaptation to local market demand**, allowing for standardisation and simplification of certain subcomponents.

Moreover, the EDU has already undergone **design and manufacturing optimisation**. This includes:

- A compact and modular architecture to reduce assembly complexity;
- Selection of cost-effective materials without compromising performance;
- Streamlined production processes adapted to local industrial capabilities;
- Partnerships with Indian Tier-2 and Tier-3 suppliers for non-critical parts.

In summary, the EDU within the GIANTS platform is already **one of the most mature and cost-optimised subsystems**, especially due to its localisation in India and the completed development efforts. Any future cost reductions will require strategic design evolutions or further scaling in production volumes.

3.5.2 Vehicle Control Unit

The Vehicle Control Unit (VCU) plays a central role in the e-Driveline system, acting as the main controller that manages high-level vehicle functions such as torque coordination, powertrain communication, and diagnostics. Despite its relatively small size, the VCU involves a high degree of complexity due to its software requirements, processing capabilities, and connectivity features.

The **main cost drivers** for the VCU are its **electronic components**, including microcontrollers, connectors, and printed circuit boards (PCBs), as well as software **development and integration**. These components are sensitive to market fluctuations in the electronics industry and are subject to global supply chain volatility.

To address cost pressures, VCU's **production has been localised in China**, a strategic choice driven by the availability of:

- A mature electronics manufacturing ecosystem;
- Established suppliers with competitive pricing;
- Access to local sourcing of key components, reducing import duties and logistics costs.

In addition, the VCU has already undergone significant **development and industrial optimisation**, including:

- Standardisation of the hardware platform across vehicle types; (only software is customised)
- Use of widely available and scalable microcontroller architectures;
- Lean manufacturing processes with automated testing and assembly;
- Pre-certified hardware for easier regulatory compliance.

Thanks to this localisation and optimisation, the VCU is currently produced under **cost-efficient conditions**. The development process has already maximised the balance between performance, safety, and affordability, making additional short-term cost reductions limited unless major technological changes are introduced.

In conclusion, the VCU within the GIANTS platform is already **fully optimised in terms of development and production**, with **competitive cost levels** enabled by its manufacturing base in China. Any future improvements would likely come from **next-generation design evolutions** rather than adjustments to the current production setup.

3.5.3 Battery System

The modular, scalable battery system used for the present assessment consists of a battery pack and an on-board docking station (see Figure 3-1).

Each battery pack includes different electronic and functional parts, such as the BMS (battery management system), power and signal connectors, and housing parts (enclosure, cell holders, insulation, thermal conductors, and sealing parts).

The on-board docking station is considered as the basic, scalable counter component allocating one battery pack.
The technical reference used in chapter 3.5 for the pricing of the complete battery system (battery packs + on-board docking stations) consists of two main vehicle variants, a low- and a high-power variant (see also Figure 3-6).
In adherence with the swappable battery approach mentioned in the GIANTS Grant Agreement, the NMC (Nickel Manganese Cobalt) cell chemistry combined with the widely accessible cell format 21700 offers the balance between energy density/weight, modularity, and price.

When compared to a space-consuming LFP solution (+30%), the tendency to select the NMC chemistry for swappable battery systems becomes clearer. The battery pack definition studied in detail within WP3 suggests a battery configuration of 14S10P: 14 cells are connected in series to reach the system voltage requirement, and 10 cells are connected in parallel to reach an economical balance with power and capacity sizing.

By this definition, each swappable battery pack offers an effective usable battery capacity of 2,2 kWh.

The comparison to another battery configuration 14S7P (which offers a total effective capacity of 1,4 kWh) was done and resulted in significant differences in respect to performance requirements of the powertrain, and other economical differences.

It can be concluded that the reduction of battery pack capacity affects the number of battery packs needed to fulfil the required power levels (more determining factor then range); this increasing the ratio expressed in [EUR/kWh]. Additionally, it causes an increase in the battery pack bill of material cost (e.g. extra BMS, housings, connectors etc.), which also drives the battery system cost expressed in [EUR/kWh] to higher levels to fulfil the same objective.

To evaluate more on the NMC cell pricing - which is compared to LFP currently ca. 20 – 30% more expensive[1] - it is forecasted for the NMC cell between 2023 and 2030 to experience a substantial transformation, driven by a convergence of technological, market, and regional shifts. Drawing upon insights from Wood Mackenzie, SNE Research, Goldman Sachs, and BNEF, consensus forecasts predict a 39% reduction in market prices for battery cells over this period. This deflationary trend reflects both strategic market overcapacity and advancements in cost efficiency, with implications across the entire lithium-ion battery value chain[2].

One of the most significant drivers is the cost reduction of cell production, stemming from increased automation, enhanced process yields, and optimized supply chains. The battery sector is moving toward higher automation and more sophisticated manufacturing, which has led to lower operating expenses (Opex) at major cell suppliers. These savings are passed down the value chain, resulting in more competitive pricing per kilowatt-hour (kWh).

Moreover, oversupply in NMC (Nickel Manganese Cobalt) cells, particularly due to legacy investments made in anticipation of sustained demand, has created downward price pressure. Meanwhile, the People's Republic of China has strategically pivoted toward LFP (Lithium Iron Phosphate) chemistries, which are generally cheaper to produce, more stable, and better suited for applications like energy storage and mass-market electric vehicles (EVs). This strategic shift has widened the gap between installed capacity and actual demand for NMC, accelerating market price compression.

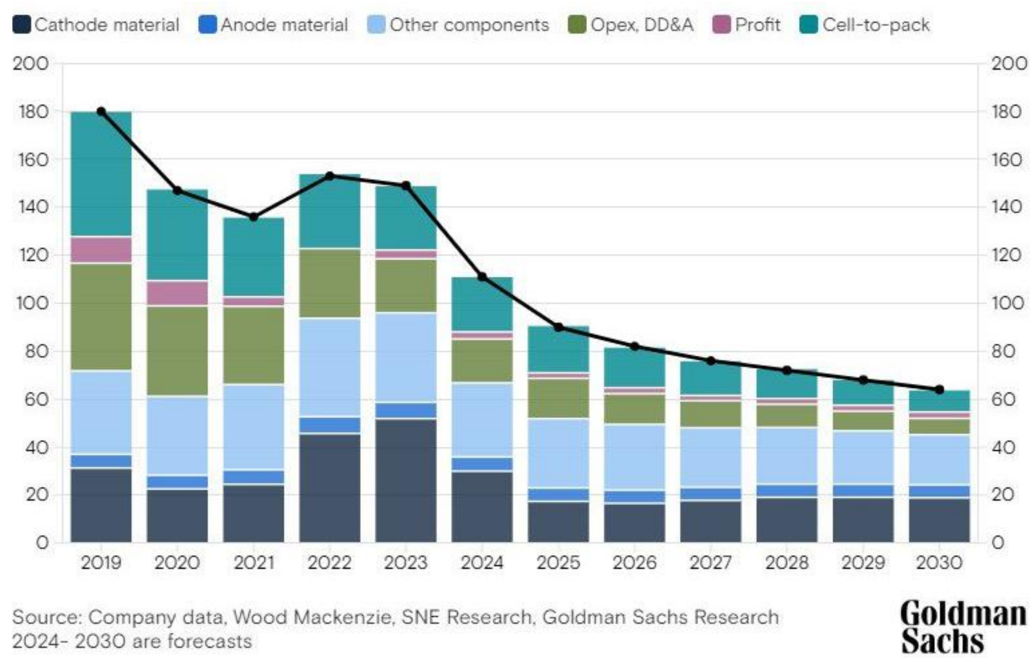

Figure 3-6: Battery Prices Forecast (Average in US$/kWh)

[1] NMC versus LFP Cost Development. December 10, 2024. https://www.batterydesign.net/nmc-vs-lfp-costs/

[2] Wood Mackenzie, SNE Research, Goldman Sachs Research. Forecasts 2024 – 2030. https://thedriven.io/2024/10/16/ev-battery-prices-to-fall-by-nearly-50-pct-and-near-ice-parity-by-2026-says-goldman-sachs/

Additionally, material costs for key components such as cathodes have continued to decline due to improved extraction technologies, better recycling practices, and diversified sourcing strategies. Innovations in battery packing and integration - including modular and application-specific formats - have further driven cost reductions. Tailored battery systems are now more commonly optimised for specific vehicle platforms or stationary storage configurations, allowing for lower energy usage per kWh delivered (lower EU/kWh) and higher system efficiencies.

While projections beyond 2030 remain speculative due to data constraints, the 2025 - 2030 period serves as a reliable basis for forecasting, leveraging consistent outputs from leading market intelligence providers. The combination of technological evolution, strategic overcapacity, and cost-down initiatives across the supply chain firmly supports the projected price decline trajectory, establishing a new baseline for long-term battery market competitiveness.

3.5.4 Solar panel and Maximum Power Point Tracker (MPPT)

Below the specification of the solar panel, note that roof structure is not part of the solar panel cost to standardise the price of the solar panel and accommodate the different configurations of the OEMs.

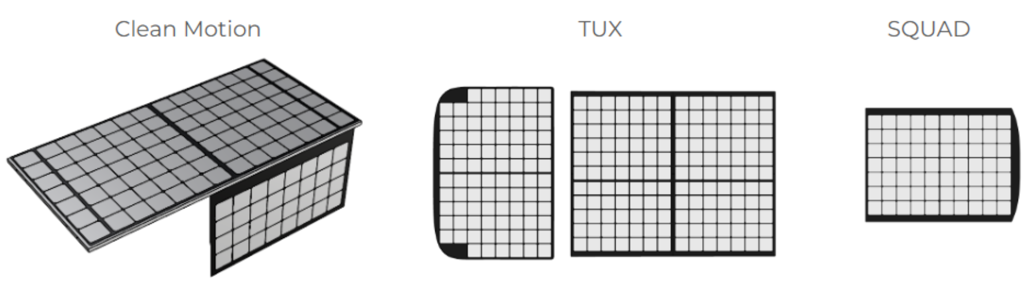

Figure 3-7: Solar panel layout for CleanMotion, TUX and SQUAD

Spec	Low Power (LP)	High Power (HP)
Solar panel standardized shape	Standard 2D	Standard 2D
Solar panel power density [Wp/m²]	200 (zebra)	200 (zebra)
Solar panel size [m²]	1.5	3
Number of MPPTs	1	2
Solar panel standalone body?	roof delivered by OEM, Solbian does lamination on it & sends back finished product to OEM	roof delivered by OEM, Solbian does lamination on it & sends back finished product to OEM

Figure 3-8: Solar panel detailed specifications

The solar panel shape was agreed to be flat (2D) for cost-efficiency, as this design allows the use of standard manufacturing equipment, enabling highly automated and scalable production processes. However, compared to a standard solar panel, the integration of specific roof materials (metal sandwich, glass-fiber, etc.) requires an adaptation process for each vehicle.

Solar Panel Standard Lamination Process (Module-Level)

During the solar panel assembly stage, photovoltaic (PV) cells are soldered together into strings, laid onto a backing sheet, and laminated between layers of EVA (Ethylene-vinyl acetate), the most widespread encapsulant film) and tempered glass using heat and pressure. The laminated panel is then framed with aluminium, fitted with a junction box (see Figure 3-10).

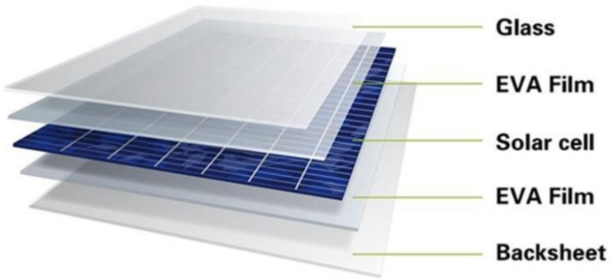

Figure 3-9: Example of standard solar panel bill of materials

The main cost-drivers are:

- Solar cell, specifically Zebra back-contact cells, that combines durability, aesthetics and competitive price;
- The electronics of the DC-DC boost converter with MPPT;
- The polymers composing the solar panel.

Sourcing of all these components is in Asia.

Competitor analysis for MPPT could not be representative enough, as the available information refers to solar charger that are not integrated into the vehicle system (no CAN communication) and primarily address the residential and marine sectors. As reference, the price for off-the-shelf Victron and Genasun MPPT, with the same peak power, ranges from 100€ to 200€ per MPPT.

In GIANTS, the following technical choices significantly contributed to reducing the price compared to competitors:

- Remove the user-interface (VCU will perform it);
- Limit maximum input power to 300Wp.

Competitor analysis for Solar Panel highlights more than 15 companies that developed or are developing solar panels integrated into the vehicle. All companies utilise mono-crystalline silicone (mono c-Si) solar cells. While most of them integrate solar cells using a glass frontsheet (AGC, A2-solar, AGP, Trina, Lightyear Layer, etc..), there are also companies that employ polymeric front-sheet. Unfortunately, since the market is still developing, no price cost was publicly available.

Considering the frugality of GIANTS, the aesthetic does not play a dominant role compared to cost and functionality; therefore, it is possible to use polymers from the solar industry that are more price competitive. The price for the Solar Panel only is indeed well below 1€/Wp , before integration on the vehicles.

3.5.5 Internet of Things (IoT)

The IoT kit offers fleet management functionalities and data for digital twins. The current feature-set includes a GNSS module for geolocation tracking, a CAN-bus module to read vehicle-data, an IO-module to read a physical button and output signals via relays and an LTE-M/CAT1 modem to send data to the cloud. A battery is included in the device to offer tracking capabilities when the drive-battery is powered off.

The main contribution to unit price (Figure 3-7) is the LTE modem (~50%), quickly followed by GNSS (~25%) and the internal standby-battery. As with all electronic devices, the price per device is reduced dramatically with the number of units produced. Cheaper, less precise sensors could be used to lower the cost of the IoT device, but especially during the first years more precise digital twin data can lead to better models and therefore rectify the added costs.

Yearly service costs for SIM-card / internet connectivity are estimated at 10$ per year per device for an average data usage of 1GB/year. This rate allows border crossing on continents and could potentially be reduced for domestic-only usage.

Competition with this wide feature set is sparse. Comparable systems have a price range between 110€ (Teltonika FMC650) and 200€ (InHand Networks VT300) and are potentially still lacking functionality like combining CAN-bus commands with physical interactions on buttons / electrical output control.

3.6 Consistency check & pricing critical review

The proposed platform appears to be significantly misaligned with the fundamental principles of a frugal vehicle. By definition, a frugal vehicle must meet basic transportation needs at the lowest possible cost, prioritising affordability, simplicity, and efficiency over high-end performance or advanced features.

According to an analysis based on benchmark pricing (including the Mobilize Duo in the Netherlands), publicly available data, and internal OEM's insights, the cost of the LP version appears to be approximately 25% too high, and the HP version around 35% too high, even when compared to advanced market. With such positioning this solution becomes clearly unviable in emerging markets, where price sensitivity is much greater and purchasing power is lower.

Moreover, such pricing not only excludes emerging economies – it also raises serious doubts about competitiveness in more mature markets, where affordable urban mobility solutions are increasingly being sought. The frugal segment is not about innovation at any cost; it is about delivering essential value efficiently. If the platform fails to deliver that value within the expected cost envelope, its market potential is drastically limited.

In short, cost reductions need to be implemented through technical simplifications, smart sourcing, and optimised manufacturing. These cost reductions are explored in section 3.7.

3.7 Different strategies to increase GIANTS platform's competitiveness

3.7.1 Increase affordability of Electrical Drive Unit and Vehicle Control Unit

Within the framework of T2.4 and T3.1 a benchmark on the landscape of EDU+VCU has been performed (see Figure C-1 in Annex C). Some pricing from India or China markets are available and displayed in the chart. Giants VCU+EDU price is consistent with this benchmark, some price difference can be fully explained by GIANTS specifications such as the interfaces (swappable battery and solar panel).

EDU: Given already done optimisations and the strategic localisation in a cost-competitive region, the current version of the EDU offers limited additional margin for cost reduction without compromising its technical performance or quality standards.

However, further savings could potentially be explored through:

- Long-term supplier agreements and volume-based procurement;
- Design-to-cost strategies for next-generation EDU versions;
- Integration of power electronics into a single housing to reduce material usage and assembly time.

VCU: Future optimisation opportunities could include:
- Greater hardware-software integration to reduce component count;
- Further standardisation to enable higher economies of scale;
- Use of alternative chipsets or simplified architecture where regulatory constraints allow.

3.7.2 Increase affordability of the battery system

Swappable batteries are explored as a mechanism to decouple vehicle cost from battery ownership. For instance, by not owning but paying for use or leasing a battery instead of purchasing. This can have major positive implications for wider accessibility. Running cost can be borne with a smaller down payment - to gain access to a LEV - and the remaining costs are to be amortized on a subscription basis, creating recurring revenue streams. Note that a shift in attitudes towards “ownership” among both Gen Z and Millennials indicates an openness to leasing (L)EV batteries separately from the rest of the vehicle. Given that Gen Z and Millennials are the current and future entrepreneurs leading electrification, this shift in behaviour is paving the way for novel approaches.

While swappable batteries are explored as a mechanism to decouple vehicle cost from battery ownership, the path to significant battery price optimisation lies in deeper structural, technological, and operational changes throughout the value chain. With the backdrop of a projected 39% decline in battery cell prices between 2023 and 2030 (see chapter 3.5.33.5.1), stakeholders have a unique opportunity to amplify cost reductions through strategies that go beyond chemistry and scale.
Within the framework of T2.4 and T3.1 a benchmark on the landscape of swappable battery systems was performed (see Figure C-2 in Annex C). However, insufficient pricing data, differences in the individual solutions, and deviating focus applications (e-bike, e-scooter) all make it difficult to create a reliable market reference.
The following text outlines approaches of battery price optimization that can deliver both short-term efficiencies and long-term competitiveness.

Design-to-Cost Engineering: Battery packs can be redesigned not only for energy density but also for manufacturability and cost. Design-to-cost (DTC) approaches prioritise functionality, modularity, and scalability over performance excess, allowing for simplified assembly and component standardisation. Examples for this approach are minimising inactive materials (casings, connectors) to improve energy-to-weight ratio, and/or cross-platform component reuse to reduce development and tooling costs.

Manufacturing Scale and Process Innovation: Battery factories are becoming increasingly automated, with digital twins, AI-based quality control, and machine learning-driven yield management systems. The key levers are:

- Factory-as-a-product design to rapidly deploy standardised production lines;
- High-throughput cell stacking and calendaring;
- AI-driven predictive maintenance to minimise downtime.

Software-Defined Battery Optimisation: Battery management systems (BMS) are evolving from simple charge controllers to sophisticated platforms that optimise thermal performance, charge rates, and usage patterns based on real-time analytics. This software layer can significantly reduce operational inefficiencies, extending cycle life and delaying the need for replacement. The software levers for cost efficiency are:

- Adaptive charging algorithms and fleet-wide energy use optimization;
- BMS predictive maintenance and state-of-health monitoring.

Battery Lifecycle Management: The full economic potential of a battery is not realized at the point of vehicle integration. Extending battery value through reuse in second-life applications and enhancing end-of-life recovery, can amortize cost over a longer value chain. The optimization potentials can be designed for disassembly and reuse, integrated health monitoring systems to track second-life viability, or partnerships with recycling firms to monetize material recovery.

Localized Production: Due to a lack of level playing field in terms of legislation, developing a G system that meets the price expectations in emerging markets such as India requires consideration of localized production. Manufacturing in India for the Indian market can provide estimated savings of 15 – 30% on battery system costs. However, this approach would exempt the production from EU labour, environmental legislation, and the EU Battery Regulation

In summary, battery price optimization, is interlinked with the evolution of manufacturing practices, material science, digital infrastructure, and system-level thinking. By taking an approach that integrates cost-down strategies across design, production, and lifecycle, stakeholders can offer competitive advantages. As battery technology matures and industry best practices converge, the opportunity lies not just in lower raw costs, but in smarter deployment, reuse, and value extraction across every stage of the battery's life.

3.7.3 Increase affordability of solar panel

For the European market, solar panels’ competitiveness is considered good. (see 3.5.2)

For Emerging markets, moving production to for example India might have an impact on the Solar Panel + MPPT, reducing the labour cost and therefore the total price by about -4% (not more because the process is highly automated).

3.7.4 Reduce CAPEX & R&D costs part in GIANTS platform price

In our set of hypotheses (section 3.3), it is assumed that strategic stakeholders are ready to advance money to private industrial companies and to support the risk in case of no take-off. If volumes are there, they will be reimbursed in 4 years, thanks to this CAPEX& R&D cost part in the platform’s price.

This part of the platform’s price can be reduced if the creditors agree to increase the term of loan.

3.7.5 Other general considerations to improve competitiveness

- The combination of battery swapping and solar panel integration represents an innovative solution for sustainable mobility; however, it currently remains a costly option due to the complexity of the infrastructure and the high initial investment required. A platform variant with fixed battery and without solar panel could be created, bringing a significantly lower entry price. It could be a way to facilitate the LEV’s take off, especially for private customers not so much interested by high range & quick charging.

- Displayed prices are the best knowledge of the industrial partners at the moment. We should consider a global learning curve - different of what can be displayed by each component. The usual rate for OEMs is about 3- 5 % by year.

3.8 Toward mass production within the EU

In previous section 3.7, we listed what could be done to decrease GIANTS Platform price.

Beyond these cost reductions, there is obviously more works to do to transform this “paperwork” **into an industrial off-shelf component**, widely available for small and big OEM, certainly:

- GIANTS platform will need further design, optimisation and validation and should benefit from GIANTS demonstration feedback;
- GIANTS stakeholders should find a “distributor” gathering the different components of GIANTS platform.

This was defined in the GA:

Year after project end	Exploitation of GIANTS platform	Projected overall revenue
1 (2029)	Further development of platform technology and buildup of production capacities within small OEMs manufacturing demo-vehicles, further development of components at component suppliers, further developments for use of GIANTS platform for vehicles produced by large OEMs.	

Figure 3-10: Year 1 after project end (GA extract)

- Above all, the GIANTS platform will require an investor willing to provide funding to initiate the industrial production of all its components;
- Implementing policies favourable to this type of vehicle could foster adoption and decrease the investment risk. That is described in section 4.

4. Building a policy dialogue with stakeholders to refine policy recommendations

Part of the path towards supporting the mass adoption of frugal LEV solutions is outlining the business model, such that the solution is feasible in the market and with public authorities. With that now presented, another essential part is providing policy recommendations.

The outcomes of the user needs assessment developed under WP2 already provide guidance on future scale-up and adoption of frugal LEVs. In particular, the need to develop mission-centric vehicles (including charging infrastructure) that can be adapted to different use cases, both in urban and peri-urban environments (different use cases require different functionalities, e.g., battery swapping may be better in urban contexts and for passengers/goods distribution, while suburban uses may be more dependent in home charging). The project's extensive user needs assessment, which included feedback from a diverse range of stakeholders, including end users, public authorities, fleet operators, and OEMs, allowed for the identification of key expectations across user profiles and outlined some preferences, concerns, and persona transport patterns. Safety emerged as a top priority, particularly for older users. Additionally, over-engineering remains a barrier to affordability, even for compact urban vehicles, highlighting that designing these vehicles should meet essential needs without added, unnecessary costs. Future policy and regulatory frameworks should consider that while these vehicles should have requirements that are compatible with the frugal nature of LEVs (both in price and technological developments), aspects such as safety of passengers and pedestrians in case of accident should not be overlooked.

Another aspect to consider in future policy recommendations is the role of these frugal LEVs in the urban mobility ecosystem. According to the stakeholder exchanges held so far (in particular with city authorities), frugal LEVs should not contribute to increased vehicle numbers in cities, but offer viable, space-efficient replacements for existing oversized cars - particularly second vehicles. Urban spaces, including roads, are a scarce commodity which must accommodate the needs of different users, including car drivers, pedestrians, and all kinds of transport modes. However, the growing trend of cars becoming bigger has exacerbated the conflict between car drivers and vulnerable road users, as well as making shared spaces less safe, and therefore, less attractive. It is imperative that cities and regions are provided with the right tools to tackle the spread of bigger, heavier, and taller car models like SUVs in urban contexts. Research & innovation projects like GIANTS can help to develop and test novel solutions aiming to support local and regional authorities providing an effective response to the growing mismatch between urban mobility needs and prevailing vehicle trends. In this context, GIANTS is advancing the development of frugal, zero-emission vehicles tailored for city environments that provide more energy-efficient mobility of people and goods.

While regulations are dependent upon the geographical region and local politics, the goal is to provide some overarching policy recommendations. The results may also provide some more focused recommendations broken down for various contexts.

4.1 City engagement

As the GIANTS pilots start their implementation phase, it will be important to engage with city authorities to ensure:

- Knowledge about pilot objectives and approach;
- Alignment between project objectives and urban mobility strategies;

- Input and validation from these public authorities, that can inform the project's final round of policy recommendations.

For this, a concrete plan of activities will be developed to guarantee city involvement, particularly the organisation of meetings between project partners and city representatives, as well as a series of focus groups aiming to collect input on topics such as:

- The awareness of the emergence of frugal LEVs by local governments;
- What are the perceived implications of these vehicles for urban mobility;
- If the vehicles are perceived as an opportunity to address issues such as parking policies, energy efficiency, environmental benefits and road safety and what are the main impacts of the perception;
- What responsibilities fall within the scope of local governments to enable the adoption of frugal LEVs, including financial incentives and charging infrastructure;
- Discussing the barriers and motivators for users and potential benefits to cities, such as a reduced footprint if replacing traditional larger ICE vehicles, lower pollution;
- Implementing policies that support a sense of safety and balance in transport spaces from all perspectives (L-class user safety in relation to larger vehicles on the road vs. optimising safety and maintaining separate dedicated space for more vulnerable users such as bicycles and pedestrians). The prioritisation and (re)allocation of space allowing L-class users and other larger, faster, motorised vehicles to ensure road safety for all should be (re)considered;
- How to effectively integrate the vehicles into the urban mobility landscape: e.g., allocation of space, licensing, and implementing consistently safe speed limits within city limits and operational areas.

These focus groups should benefit from the inputs provided by WP2 and should be informed by the developments and results of the tasks and activities in WP4 and WP5.

4.1.1 City engagement in India

Since the various cities and demonstration sites have different contexts and policy frameworks, the following presents a proposed approach to city engagement tailored to India.

As the GIANTS pilots enter their demonstration phase, engaging with city authorities in India is critical to ensure successful deployment and long-term impact. For GIANTS, this engagement serves multiple purposes: it builds awareness of the pilot objectives and technology among local governments, aligns the project with national and city-level mobility strategies, and ensures that the policy recommendations emerging from GIANTS are informed by practical realities on the ground.

The planned city engagement will begin by introducing the concept of frugal LEVs, with a specific focus on electric three-wheelers for goods and passenger transport. This introduction will include briefings to city authorities, covering the technical specifications, operational use cases, and the broader objectives of the GIANTS project. It is crucial that local officials understand how these vehicles can contribute to their goals of reducing congestion, improving air quality, and meeting electrification targets under national schemes such as FAME-II and state EV policies.

4.2 Stakeholder mapping and engagement

To achieve stakeholder mapping and engagement, project partners will develop a structured plan of activities. This will involve mapping stakeholders across target cities such as Pune and Delhi NCR and identifying relevant municipal departments and urban local bodies. Through this mapping, the consortium will ensure that all critical decision-makers are engaged.

The engagement will take the form of focused meetings organised between GIANTS partners and city representatives. These interactions will present the pilot objectives, deployment plans, and expected outcomes. Also, city authority input will be gathered on key topics, such as their awareness of emerging frugal LEVs; their perceptions of the implications these vehicles have for urban mobility systems; and the extent to which they see LEVs as an opportunity to address challenges including parking management, energy efficiency, environmental sustainability, and road safety.

These discussions will also explore the roles and responsibilities of local governments in enabling the adoption of frugal LEVs. This includes examining the scope for financial incentives, charging or battery swapping infrastructure planning, and licensing frameworks needed to operationalise such vehicles at scale. Importantly, barriers to adoption, such as regulatory bottlenecks, will be identified alongside motivators such as operational cost savings, reduced vehicle footprints, and the contribution to air pollution reduction targets.

Role of GIANTS partners and input for other work packages

Project partners working closely with the demo sites and vehicles, and those exploring the existing policy frameworks and final policy recommendations, together with the local OEMs, will play a leading role in city engagement activities. Responsibilities include coordinating the meetings, presenting vehicle demonstrations and real-world performance data, and co-developing pilot implementation plans with local fleet owners and city authorities. Furthermore, project partners will consolidate the regulatory requirements and policy insights gathered through these engagements, ensuring they feed directly into GIANTS' technical development work and final policy recommendations.

These activities will be carried out in coordination with GIANTS work packages.

4.3 Initial policy recommendations

Below are some initial policy recommendations resulting from the survey and the knowledge gained so far. The survey provided information from respondents representing a broad range of demographics, including various geographic areas, levels of income, and markets (advanced, emerging). This first set of recommendations is derived from the insights and data gained from the survey results, analysed in D2.2, through knowledge gained in discussions within the project (collaboration with a pool of experts within the consortium), initial discussions with stakeholders, desktop research, and background knowledge.

Affordability and Incentives:

- Purchase costs were the highest priority from the results of the survey / KANO analysis on various levels. As a key component, and keeping in mind the goal of EU competitiveness, subsidies and tax incentives should be recommended on the higher EU level and filter down to the national, regional, and local levels. The goal is to encourage the purchase of these frugal EVs in the GIANTS project to replace traditional Internal Combustion (IC) vehicles, rather than simply adding more vehicles to overall ownership, so trade-in / swapping incentives could be useful. Financial policy shifts to support these vehicles should also consider and aim to avoid shifts from public transport and active travel.

Safety Considerations– Users, transportation of children, fleet operators, other road users

- Local authorities should implement consistent approaches to improvements to the built environment (improved infrastructure) in which the vehicles would operate. Infrastructure design is integral in supporting safe user behaviour as well as reductions in speed, which results in improved safety. The perception of many survey respondents linked low speeds and safety. The continued rollout of 30 km/h zones would support further uptake and integration of frugal LEVs into the urban mobility landscape.
- A large percentage of survey respondents felt that frugal LEVs were not safe to be operated on faster roads (>70km/h). The operational areas of such vehicles could be limited to 30/50 km/h zones by law, especially taking into consideration vehicle safety features in place, driver safety, and the potential consequences of operating alongside much larger and faster vehicles on highways, rural roads (where perhaps speed limits should be lowered to invite adoption and safety), etc.
- A standardised, affordable, and efficient (time-wise) approach to crash safety testing and rating/requirements would be useful from a regulatory perspective. This could be limited to meet the expectations of safety at speeds of 30-50km/h if those operational limits are established. (Safety features preferred from the survey included: Side/rear view mirrors, ABS (anti-lock braking systems), airbags, headrests, crumple zones, collapsible steering column. Additionally, fleet operators prioritised robust security and safety features to protect drivers, passengers, and assets while ensuring operational efficiency. Key safety expectations include standard measures such as seatbelts, airbags, collision warning systems, and emergency braking assistance to mitigate risks during accidents.
- Larger and heavier vehicles should be discouraged from operating within the primary operational areas for L-class vehicles and other smaller, lighter forms of transport, in combination with a consistent implementation of 30 km/h driving zones within cities/operational areas to minimise potential injuries. Policies such as differentiated parking fees for heavier vehicles, as well as traffic circulation restrictions based on vehicle weight, can contribute to this.

Safety Considerations - General public / usage in public space

- GIANTS type vehicles (L5, L6, L7) should not be allowed to operate in dedicated active transport infrastructure (bike lanes, pedestrian zones, etc.) as this poses risks and reduces safety for more vulnerable road users (since the vehicles are heavier and faster than cyclists, scooters, pedestrians). The friction would also likely contribute to negative public perception of GIANTS-type vehicles, since there is already a large allocation of public space for the vehicles on roads.
- Survey respondents from a range of areas generally felt these vehicles (L5, L6, L7) should have a licensing requirement and that 18 years of age was an appropriate starting age to operate such an LEV. This could be a recommended policy recommendation on the national level that could be put in place to cover these categories of vehicles.

- Infrastructure provisions should be made to enhance the allocation of space and separation of vehicles (*protection of L5, L6, L7 users from* larger vehicles), and *protection of* active transport users (manual pedal bicycles, pedestrians) *from* L5, L6, L7 users. This requires policy that balances the implementation of infrastructure designed and allocated for the safety of all, speed limit reductions, enforcement, and accountability.

Security

- The only security feature that was prioritised in the survey was the inclusion of the standard feature in traditional vehicles – doors. Fleet operators generally indicate higher interest in features such as GPS tracking. On the local policy level, recommendations should support enforcement levels that protect these vehicles and their owners, rather than disregard vandalism and thefts, as is often the case with bicycles and smaller LEVs, which are generally not followed up on or a priority for police and local authorities. Such vehicles are generally a considerable investment, and often the users primary form of transportation. A lack of enforcement disregards the loss of investment in more sustainable transport options, discouraging continued investment and usage. This could also lead to people returning to heavier, less sustainable alternatives.

Public and private charging

- Survey respondents predominantly indicated that having ample charging stations throughout their local area was important. Therefore, to support adoption, cities should assess local charging infrastructure. This could be boosted through collaborations between the public and private sectors where co-investments and cooperation exist to adapt and upgrade the resources of existing facilities to add charging and reallocate space (private parking garages, etc.) to keep costs down. This also reduces to need to invest in new infrastructure from scratch and reduces adding to the vehicle footprint by adding charging stations on the street level and other public spaces.
- While cities often aim to reduce street parking, if relevant, it is suggested not to take away space from other modes of transport to provide charging stations for street parking, for example, avoiding placing them on the sidewalk. If implemented, space should be taken from existing parking spots (not placing charging stations on sidewalks, in bike lanes, etc.).
- City policies can be assessed to update housing regulations for existing as well as new homes and apartments to set standards/minimums for developers and owners to provide access to home charging in on-site parking, underground parking facilities, etc. This can help avoid charging cables blocking public sidewalks, etc.

Parking

- Parking fees should correlate to vehicle size, time of day (dynamic use of space), and demand.
- Parking access, allowances and limitations, should be in order as far as policy and infrastructure to support a balance of space for vehicle operations and public storage in areas where it is *needed* (hospital, local grocer, pharmacy, quick pick-ups and drop offs) and redirected to peripheral areas when vehicular usage should be discouraged (towards park and ride, incentivising shifts to PT in multimodal hubs, diverting traffic away from schools, etc.).

Supporting Adoption

- Local level: Subsidies, grants, and trade-in incentives will boost uptake if users feel these vehicles offer a safe, reliable, and affordable transport option.
- EU level: Financial incentives for manufacturing of components and vehicles would support EU-level innovation, cooperation, employment, and determination of the type of vehicles on the market and reduce dependence on other markets.
- EU level: Competitiveness is enhanced by the collaborations and testing of new ideas such as the GIANTS project. Creating 'clusters' of projects that are staggered in their start/end dates and can learn from previous projects would be a useful strategy as far as continuation. This would include evolving calls and including some of the overlapping partners, technologies, and platforms for further usage as the projects and the goals advance.

5. Conclusion

Deliverable D2.3 represents a key step forward in the GIANTS project by establishing the business model for the GIANTS platform and proposing an initial pricing framework based on industrial inputs and projected volumes. The deliverable defines platform prices across components and variants, providing a solid foundation based on industrial knowledge available today. These reference prices, while preliminary, serve as a credible starting point for assessing economic feasibility and market competitiveness across multiple use cases and geographies.

The deliverable highlights both the opportunities and limitations of the current pricing structure. While cost reductions have been explored, particularly through localisation and design simplification, further iterations are needed to fully capture the effects of the learning curve and to reflect the evolution of technology and market dynamics. Time remains in the project timeline to refine this business model – most notably in Deliverable D2.4, where feedback from the demonstrations and technical evaluations will allow for a final optimisation of both prices and volume assumptions.

In parallel, a supportive policy landscape is emerging. Volume uptake is expected to be robustified by clearer, more favourable policy signals for L-category vehicles at both EU and national levels. To support this, the consortium has begun outlining a path for policy engagement and city collaboration in Europe and in emerging markets such as India. The initial stakeholder mapping and the first round of policy recommendations provide a critical link between technological viability and real-world deployment, ensuring that frugal LEVs like those enabled by GIANTS can contribute meaningfully to sustainable urban mobility.

Stakeholder engagement, deeper city partnerships, and the co-creation of more targeted policy will continue to inform the final business and policy framework in D2.4 and pave the way for investment decisions, infrastructure development, and operational strategies required for successful large-scale market deployment.

D2.3 delivers a first strategic and technical synthesis for the GIANTS platform business model and sets the stage for refinement and alignment with broader societal goals, including climate neutrality, urban mobility, and inclusive innovation. The forthcoming work – combining demonstration results, stakeholder dialogue, and final business model adjustments – will be pivotal in achieving the GIANTS project's ambition: accelerating the adoption of frugal, modular, and sustainable light electric vehicles in both advanced and emerging markets.

6. Abbreviations

Term	Definition
AI	Artificial Intelligence
BMS	Battery Management System
CAPEX	Capital Expenditure
DTC	Design-to-cost
EDU	Electrical Drive Unit
EVA	Ethylene-Vinyl Acetate
EV	Electric Vehicle
GA	Grant Agreement
Gen	Generation
GIANTS	Green Intelligent Affordable New Transport Solutions
HP	High Power
IoT	Internet of Things
LFP	Lithium Iron Phosphate
LP	Low Power
MPPT	Maximum Power Point Tracker
NMC	Nickel Manganese Cobalt
Opex	Operating Expenses
PU	Public
R	Document, Report
R&D	Research and Development
SOI	System of Interest
VCU	Vehicle Control Unit
WP	Work Package

A. Annex D2.2 Update: Mission Suitability Profile for Fleets

This part is a complement to D2.2, extending the Mission Suitability Profile to another type of customers, ie fleets and more generally for anyone who wants to use GIANTS vehicles for professional use.

Below are reminded the 3 professional profiles identified and described in D2.2 and presented here in the order of the level of requirements needed:

#6 Service Providers

Table 3-7: Persona Profile for Service Providers

 **Name:** Tom **Age:** 20-35 **Life Stage:** hard-working and dynamic lifestyle **Occupation:** Independent business (e.g., carpentry, plumbing, or electrical work) **Income**: Low to medium	**Mission**: • **Small Business Logistics:** Travels to clients' homes, offices, and job sites to complete repairs, installations, or maintenance work. His vehicle acts as a mobile workshop, ensuring he has all the necessary tools at hand. His jobs are often within short distances, requiring a quick, flexible, and cost-effective transportation solution.
• Living situation: lives in a central urban area, likely in a small apartment near major streets and busy areas. His apartment is strategically located to minimise commute times to customer destinations.	**Goals/Needs**: • **Compact Cargo Storage:** Secure storage for tools and materials, with space for 0.5–1 m³ payloads, ensuring easy access and protection during travel. • **Easy Navigation & Parking:** Small, agile vehicle to easily navigate dense urban areas and park in limited spaces near job sites.
• Current Mobility: primarily uses a compact electric van or e-cargo bikes for frequent, short trips across the city.	• **Low Running Costs:** Prioritise efficient, low-maintenance vehicles to reduce operational expenses, with an emphasis on electric options. • **Frequent Charging Access**: Regular access to (public) charging stations to maintain the vehicle's 20–50 km daily range and support 5–15 stops per day.

Figure A-1: Service providers

#8 (City) Facility Maintenance

Table 3-11: Persona Profile for (City) Facility Maintenance

 **Name:** Liam **Age:** 35-50 **Life Stage:** Experienced professional, business-oriented **Occupation:** Fleet Operations Manager (City Facility Maintenance) **Income**: Low to medium	**Missions**: • **Mobile Workshops for Tradespeople & Municipal Services**: Liam manages a fleet of mobile workshops designed to support municipal services and tradespeople. These vehicles serve as on-site service stations, allowing workers to perform repairs and maintenance for the city's infrastructure, public spaces, and municipal facilities
• **Fleet Location:** Centralised municipal service hub, allowing for efficient dispatch and access to key areas of the city or region. • **Current Mobility Options:** Medium-Sized LCVs (Light Commercial Vehicles). These vehicles are custom fitted as mobile workshops. Each LCV includes enough space to support a variety of municipal services.	**Goals/Needs**: • **Urban Access**: Vehicles must easily manoeuvre through tight city spaces and comply with local regulations while accessing service locations. • **Cost-Efficiency**: Focus on LCVs that are low-maintenance, cost-effective, and versatile for different municipal tasks. • **Range & Efficiency**: Transition to electric vehicles with a daily range of 30–100 km. • **Scalability**: Fleet should be able to scale for varying service demands, handling 5–15 stops per day. • **Storage & Equipment**: Vehicles need customisable storage solutions to efficiently carry tools, materials, and equipment for on-site tasks.

Figure A-2: City facility maintenance

#7 Large-scale logistic operator

Table 3-10: Persona Profile for large-scale logistic operator

 **Name:** Sophia **Age:** 35-50 **Life Stage:** Experienced professional, business-oriented **Occupation:** Fleet Operations Manager **Income**: Low to medium	**Missions**: • **E-Commerce and Parcel Deliveries**: Sophia is responsible for managing a team of delivery drivers, ensuring they have the tools, vehicles, and support needed to complete their routes effectively. They perform last-mile deliveries for an e-commerce giant in busy urban centres, often managing high-frequency, multi-stop routes to deliver packages and parcels quickly to customers.
• **Living situation:** Fleet is managed from a strategically located sub-urban logistics hub designed for efficient last-mile deliveries. • **Current Mobility:** Sophia's fleet consists of various vehicle types, relying mainly on Compact Delivery Vans.	**Goals/Needs**: • **Urban Navigation**: Vehicles should easily navigate through crowded areas, access restricted zones, and comply with local delivery regulations. • **Cost-Efficiency**: Focus on efficient LCVs **(Light Commercial Vehicles)** with minimal maintenance needs to optimise overall fleet costs. • **Range & Efficiency**: Transition to electric vans, aiming a daily range of 40–100 km to cover delivery routes effectively and meet operational needs. • **Scalability**: The fleet needs to manage peak periods with flexibility, efficiently handling 40–80 stops per day for last-mile deliveries. • **Cargo Space**: Vehicles should offer adequate cargo capacity (3–5 m³) to carry parcels while maximising space for efficiency.

Figure A-3: Large-scale logistic operator

For these personae (end-user or fleet managers), criteria' missions are Cargo Volume, Payload capacity, Maximum speed, Range, Vehicle efficiency, Start/stop efficiency, Price and expected safety.

The level of requirements has been defined through interviews and expertise of OEMs targeting these types of customers. They are presented in the figure below.

					OPERATIONAL EFFICIENCY				
Requirements	**Cargo Volume (L)**	**Payload Capacity (kg)**	**Speed (km/h)**	**Range (km)**	**Veh efficiency = Energy consumption (Wh/km)**	**Charging efficiency (hours)**	**Start/stop efficiency (hours by day)**	**Purchase Price (euros)**	**Expected Safety**
Small Business Logistics (Private service Provider)	**1000**	**400**	**45**	**50**	**50**	**5**	**0,25**	**14000**	**Basic to intermediate**
City Facility maintenance	**2000**	**400**	**45**	**100**	**50**	**5**	**0,25**	**7000**	**Basic to intermediate**
E-commerce and parcel deliveries	**4000**	**800**	**45**	**200**	**75**	**2**	**1**	**7000**	**Intermediate**

Figure A-4: Requirements for professional usage

The different Mission Suitability Profiles are below, visualised on a spider chart.

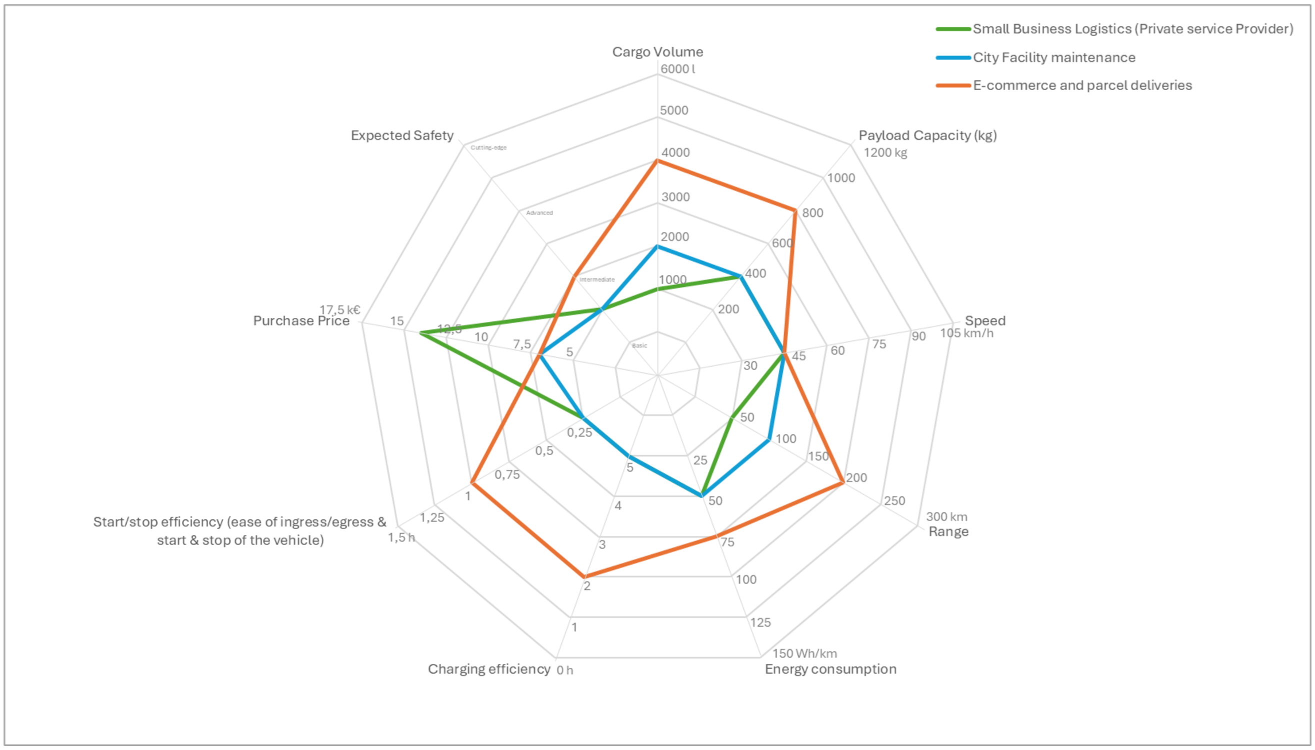

Figure A-5: Mission Suitability Profile for Professionals

Without any surprise, the chart describes a wide spectrum of expectations depending on the activities (missions), e-commerce and parcel deliveries being the more demanding profile.

B. Annex D2.2 Update: Policy Background - Barcelona

Due to the proposed shift in demo cities from Brugge, BE to Barcelona, ES – the following text provides the policy framework for Barcelona, in alignment with what was provided for the other demonstration cities in D2.2, 3.2.4 ‘Stakeholder Specific Analysis’ in sub-section 3.2.4.3 ‘Public Authorities’.

The following information is directly extracted from the cited sources:

Parking Access

As in many historic European cities, parking in central Barcelona is highly regulated and often difficult. On-street parking in the city centre is limited, especially near key attractions and high-footfall areas, with a strong enforcement regime in place. Parking violations are swiftly penalised, often resulting in the vehicle being towed – an outcome communicated via a sticker left on the road indicating the retrieval location[3].

Barcelona has implemented a tiered system of street markings:

- **Blue zones** indicate metered parking spaces for visitors, generally subject to maximum stay limits;
- **Green zones** are primarily for local residents or permit holders, though some allow visitor parking at higher tariffs;
- **Yellow lines** signal no-parking zones under any circumstance;
- **Disabled and reserved spaces** are strictly monitored, with violations penalised heavily[3].

Off-street parking is more available, primarily through the **Barcelona de Serveis Municipals (B:SM)** network, which operates over 49 modern parking facilities comprising 14,000+ spaces across the city. These garages often include charging infrastructure for electric vehicles, facilities for motorcycles and cargo bikes, accessible restrooms, and enhanced security[4]. The private sector also contributes via garage providers like **Parclick**, which allows online reservations across 257 parking sites, including nearly all B:SM garages[5].

Despite these provisions, high parking costs – typically **€25–€35 per day** in central garages – serve as a disincentive for private vehicle use[1]. Many central areas of the city, especially in "superblocks" and low-traffic zones, have restricted vehicular access altogether, prioritising active and micromobility modes[6].

While there is no specific vehicle-size-based parking scheme (as seen in Stockholm), motorcycles and electric scooters often benefit from designated parking areas that can accommodate multiple vehicles in a single car-sized space[7]. For **bicycles and personal mobility vehicles (PMVs)** like e-scooters, parking provision is increasingly addressed through city planning initiatives and PMV-specific zones, with enforcement focused on preventing obstruction of pedestrian paths[8].

In terms of city access, Barcelona enforces a **Low Emission Zone (ZBE)** covering the city and its ring roads on weekdays from 07:00 to 20:00. This restricts high-emission vehicles from entering the urban core,

[3] Barcelona.de. *Driving and parking in Barcelona – Important rules and tips.* https://www.barcelona.de/en/barcelona-driving-car.html
[4] B:SM – Barcelona de Serveis Municipals. *Parking Network and Facilities.* https://www.parclick.com/parking-barcelona
[5] Parclick. Online Reservation of Parking Spaces in Barcelona. https://www.parclick.com/parking-barcelona
[6] Interreg Europe. *Strategy for Electric Mobility of the City Council of Barcelona.* https://www.interregeurope.eu/good-practices/strategy-for-electric-mobility-of-the-city-council-of-barcelona
[7] Barcelona.cat. *Personal Mobility Vehicles (PMVs).* https://www.barcelona.cat/mobilitat/en/means-of-transport/personal-mobility-vehicle
[8] ScienceDirect (2023). *Light electric vehicles in urban mobility: Regulations and impacts.* https://www.sciencedirect.com/science/article/pii/S0967070X23003177

although **light electric vehicles** such as e-scooters, e-bikes, and other PMVs are not restricted and are instead promoted as alternatives[9].

Infrastructure Provision

In line with the concerns expressed in the end-user survey regarding the safety and suitability of road infrastructure for light electric vehicles (LEVs), Barcelona's current urban mobility strategy shows significant planning consideration for micromobility, including bicycles, e-scooters, and other PMVs.

The Metropolitan Urban Mobility Plan (PMMU) 2019–2024 and the upcoming PMU 2025–2030 demonstrate Barcelona's commitment to transforming street space to prioritise active and sustainable transport modes. PMVs and other LEVs are typically allowed on bicycle lanes and in shared low-speed traffic zones, particularly in areas designated as "superblocks" (Superilles) where motorised traffic is restricted or significantly calmed[10].

Although Barcelona does not currently have infrastructure specifically designed for L-class LEVs (i.e. L5, L6, L7), the expansion of cycle lanes (with plans for 55 km of new infrastructure by 2030) and the general move to pacify traffic (20 km of additional pedestrian-priority zones) make many city streets suitable for small-format electric vehicles operating below 45 km/h[11].

L-class LEVs are not explicitly restricted on faster roads; however, like in other cities, their integration is informal. Given the increasing street-level segregation between high-speed and low-speed transport, these LEVs tend to operate most effectively on local roads, shared spaces, and traffic-calmed areas rather than primary arterial routes.

Barcelona has also implemented an extensive Low Emission Zone (LEZ) policy – Zona de Baixes Emissions (ZBE) – which came into force on 1 January 2020 and was reinforced through a new municipal bylaw on 28 January 2023[12]. Covering over 95 km² including central Barcelona and parts of neighbouring municipalities, the ZBE restricts access to older, more polluting petrol and diesel vehicles on weekdays between 7:00 a.m. and 8:00 p.m. These regulations do not apply to LEVs, which are fully permitted within the zone, offering them a regulatory advantage compared to heavier internal combustion vehicles[11, 13].

The ZBE bylaw includes several exemptions for social or professional use (e.g., medical transport, low-income drivers, essential services) but broadly aims to push the transition toward zero-emission mobility. LEVs, being compact and zero-emission by design, align naturally with this direction.

While dedicated L-category LEV infrastructure (e.g., specific lanes or parking for enclosed light EVs) has not yet been planned in official strategy documents, PMVs and other micromobility users are clearly supported in existing and future street design. Municipal transport strategies also include improvements to bike/PV

[9] Ajuntament de Barcelona. *Low Emission Zone (ZBE) Regulations.* https://ajuntament.barcelona.cat/qualitataire/en/low-emission-zone/what-barcelona-ring-roads-low-emission-zone

[10] Ajuntament de Barcelona. *Barcelona Superblock Model: Mobility and Public Space Reconfiguration.* https://www.barcelona.cat/mobilitat/en/safe-mobility

[11] Cadena SER Catalunya. *Barcelona vol reduir l'ús del cotxe del 20% al 15% i que la mobilitat en transport públic passi del 34% al 37% el 2030.* https://cadenaser.com/cataluna/2025/01/17/barcelona-vol-reduir-lus-del-cotxe-del-20-al-15-i-que-la-mobilitat-en-transport-public-passi-del-34-al-37-el-2030-sercat/

[12] Ajuntament de Barcelona. *What is the Barcelona Ring Roads Low Emission Zone (ZBE)?* https://ajuntament.barcelona.cat/qualitataire/en/low-emission-zone/what-barcelona-ring-roads-low-emission-zone

[13] ZBE Registry. *Regulations and Exemptions.* https://zberegistre.ambmobilitat.cat/en/VehiclesEstrangers

infrastructure connectivity across districts, integration with public transport, and improved parking zones for micromobility devices to keep pedestrian spaces clear[14].

Current state of charging infrastructure

Barcelona has made steady progress in developing a public charging infrastructure that supports its growing fleet of electric vehicles, including LEVs. End-user concerns related to charging accessibility and so-called "range anxiety" are well recognised by the city authorities and are being addressed through multiple programmes and strategic investments.

All **B:SM-operated parking garages** – which represent a significant portion of the city's off-street parking capacity – include **charging stations for both electric cars and motorcycles** [13]. These garages are distributed throughout the city, allowing for predictable access to charging in central and peripheral zones. However, occupying these reserved charging spots **without actively charging** can result in penalties, including towing, highlighting the city's serious approach to ensuring these spaces remain available for genuine users[15].

The city's public charging network is branded as **"Endolla Barcelona"**, one of the largest urban charging networks in Southern Europe. As of 2024, the Endolla system offered more than **700 public charging points**, and its expansion continues under the city's **Electric Mobility Strategy 2018–2024**, which included funding from the **EU GreenCharge project** and local subsidies[16,17]. Subsidies support both **curbside and off-street charging station installation**, particularly in residential and commercial buildings, further expanding semi-public charging access.

Additionally, Barcelona has taken steps to improve the sustainability and energy efficiency of its EV charging infrastructure. One example is the **MetroCharge** initiative, a pilot programme that **repurposes regenerative braking energy from metro trains** to power EV charging stations. While still at a modest scale (approx. 28 stations connected), it reflects the city's broader ambition to integrate LEV charging into multimodal, energy-efficient transport hubs[18].

Despite the progress made, **charging infrastructure remains primarily designed for conventional EVs (M1/N1 categories)**. There is **limited dedicated provision** for L5e, L6e, or L7e-class vehicles. LEVs currently **share existing EV charging infrastructure** where compatible, particularly for enclosed vehicles (e.g., microcars or cabin scooters), but **small-format PMVs** (e-scooters, e-bikes) are more often charged privately or at workplace/commercial docking stations rather than public outlets.

Safety concerns and accessibility

As in other cities, Barcelona end-users have expressed doubts regarding the coexistence of low-speed LEVs (particularly L5/L6/L7 vehicles) with cars and motorcycles, especially outside traffic-calmed areas.

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[14] Interreg Europe. *Strategy for Electric Mobility of the City Council of Barcelona.* https://www.interregeurope.eu/good-practices/strategy-for-electric-mobility-of-the-city-council-of-barcelona

[15] Barcelona.de. Driving and parking in Barcelona – Important rules and tips. https://www.barcelona.de/en/barcelona-driving-car.html

[16] Interreg Europe. *Strategy for Electric Mobility of the City Council of Barcelona.* https://www.interregeurope.eu/good-practices/strategy-for-electric-mobility-of-the-city-council-of-barcelona

[17] GreenCharge Project. *Barcelona pilot: charging infrastructure and fleet electrification.* https://www.greencharge2020.eu/wp-content/uploads/2019/06/leaflet_GreenCharge_e-mobility_and_SUMP.pdf

[18] EVXL. *Barcelona's MetroCharge Project: Using Metro Braking Energy for EV Charging.* https://evxl.co/de/2024/12/18/barcelona-metro-ev-charging-system-regenerative-braking-energy/

Barcelona's approach to safety for all road users is rooted in its **Byelaw on Pedestrian and Vehicle Traffic (Ordenança de Circulació de Vianants i de Vehicles – OCVV)**, which was updated in **November 2024** to include new rules on **personal mobility vehicles (PMVs)** and the prioritisation of **pedestrian spaces**[19].

Key safety-related provisions of the new byelaw include:

- **Pedestrian-first principle**: Pavements are strictly reserved for pedestrian use. PMVs and LEVs are **prohibited from riding or parking on pavements** under most conditions, with dedicated infrastructure or roadways designated instead.
- **Speed regulation**: PMVs and similar vehicles must use **cycle lanes** or **30 km/h traffic-calmed streets** where available and must **not exceed 25 km/h**. L-category LEVs, depending on their configuration (e.g., three- or four-wheeled, enclosed, motor power), are subject to standard vehicular regulations and must operate on the roadway – not in cycle paths or pedestrian zones[20].
- **Helmet and lighting requirements**: As of 2025, helmets, front and rear lighting, and reflective elements are mandatory for most PMVs and L-class LEVs in urban zones. Commercial LEV users (e.g., last-mile delivery) are also required to hold third-party liability insurance.

Barcelona has also made a concerted effort to **restructure public space** through measures such as **superblocks (Superilles)** and **low-speed zones**, which reduce car traffic and speed, helping to mitigate collision risk between LEVs and heavier vehicles. Many of these zones impose **30 km/h or lower speed limits**, and favour active and sustainable transport, including LEVs and cargo bikes[21].

Regarding accessibility, **disabled parking spaces** are present across both public (on-street) and private (garage) facilities. Holders of recognised disability permits may use **green, blue, and loading zones** free of charge, subject to time restrictions[22]. This reflects the city's broader commitment to inclusive mobility, including provisions for people with reduced mobility within the wider transport system.

Age and Licensing

The Spanish and Catalan regulatory frameworks governing vehicle licensing are relatively accommodating toward light electric vehicles (LEVs), particularly in support of electric microcars and sustainable mobility. These rules apply across Spain but are actively reinforced by Barcelona's municipal mobility policies, which aim to promote zero-emission alternatives.

As of **2024**, Spain introduced a **B1 driving license** for 16-year-olds, enabling young drivers to legally operate certain L-category light electric vehicles – specifically **L7e vehicles** (quadricycles) – under defined conditions[23]. This reform was explicitly aimed at encouraging **youth adoption of electric vehicles** while maintaining safety standards.

Under the B1 license, drivers must adhere to the following vehicle restrictions:

- **Maximum weight** of 400 kg (excluding battery)

[19] Ajuntament de Barcelona. *New Pedestrian and Vehicle Traffic Byelaw – November 2024.* https://www.barcelona.cat/mobilitat/en/safe-mobility
[20] 18. Barcelona.cat. *Personal Mobility Vehicles (PMVs).* https://www.barcelona.cat/mobilitat/en/means-of-transport/personal-mobility-vehicle
[21] 19. Ajuntament de Barcelona. *Superblock Urban Mobility Model.* https://www.barcelona.cat/mobilitat/en/safe-mobility
[22] 20. Barcelona.de. *Parking and Accessibility Information for Disabled Drivers.* https://www.barcelona.de/en/barcelona-driving-car.html
[23] The Local ES. *Spain introduces new driving licence for 16-year-olds to boost use of electric vehicles.* https://www.thelocal.es/20230728/spain-introduces-new-driving-licence-for-16-year-olds-to-boost-use-of-electric-vehicles

- **Top speed** not exceeding 90 km/h
- **Maximum power output** of 15 kW

These parameters make the B1 license suitable for a large portion of LEVs in the **L6e and L7e categories**, including small urban electric microcars. It also supports Barcelona's **Low Emission Zone (ZBE)** strategy by ensuring that these LEVs – which qualify as zero-emission – have **unrestricted access to the ZBE**[24].

For **L5e-class vehicles** (three-wheeled motorised vehicles with power above moped level), a standard **B license** (minimum age 18) is required. Similarly, for **L3e** (motorcycles) and **L1e** (mopeds), age and licensing align with conventional EU licensing categories:

- **L1e (e.g., e-mopeds ≤ 50cc or ≤45 km/h)**: 15+ years old with AM license
- **L3e / L5e (e.g., motorcycles, tricycles)**: 18+ years with A1/A license
- **L6e/L7e (light and heavy quadricycles)**: 16+ years with B1 license (since 2024)[25].

While there is no **mandatory training course specifically for LEVs**, general road safety education and licensing tests include urban driving, rules of priority, and interaction with vulnerable road users. This is seen as sufficient preparation for most low-speed LEVs currently permitted under the Spanish system.

Municipal fleet use

Barcelona has demonstrated a strong institutional commitment to transitioning its municipal fleet toward sustainable, low-emission alternatives. Under the **Electric Mobility Strategy 2018–2024**, the city actively promotes the adoption of **electric light-duty vehicles and personal mobility devices** for a variety of public services, including **street cleaning, maintenance, inspections, and last-mile logistics**.

The public agency **Barcelona Serveis Municipals (B:SM)** has been at the forefront of this transition, steadily electrifying its operational fleet. This includes the integration of **compact electric vans, scooters, and three-wheeled utility vehicles**, which are now regularly used in tasks such as **parking enforcement, park upkeep, and public space management**.

In parallel, Barcelona's innovation ecosystem has fostered collaboration with local manufacturers of LEVs, notably **Silence**, a Spain-based company specialising in electric scooters and quadricycles. The company's **S04 model**[26], classified under L6e and L7e categories, is part of the city's broader testbed for compact electric mobility solutions. Its **removable battery-swapping system** offers fast turnaround capabilities, making it particularly well-suited for **urban inspection tasks and municipal logistics operations** where quick redeployment is essential[27].

Incentives/local regulation/infrastructure/policies/financial

In Barcelona, light electric vehicles (LEVs), particularly **L6e and L7e quadricycles**, benefit from a combination of **national and local incentives** that support their adoption:

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[24] Ajuntament de Barcelona. *Low Emission Zone (ZBE) – vehicle access and exemptions.* https://ajuntament.barcelona.cat/qualitataire/en/low-emission-zone/what-barcelona-ring-roads-low-emission-zone
[25] DGT (Dirección General de Tráfico). *Categorías de permiso de conducción en España.* https://www.dgt.es/conducir/permiso-de-conducir/clases-permiso-conducir/
[26] Silence. *Official Website – S04 Quadricycle.* https://www.silence.eco/en
[27] ArenaEV. *Tiny city EV with swappable batteries: Silence S04 enters production.* https://www.arenaev.com/tiny_city_ev_with_swappable_batteries_silence_s04_enters_production-news-1925.php

- **MOVES III Programme Extended** – Spain has **extended MOVES III** with an additional **€400 million** for 2025, ensuring subsidies for electric vehicles (including quadricycles) remain available through **31 December 2025**. Buyers also benefit from a **15% personal income tax deduction** for qualifying EV purchases and charger installations made in 2025[28].
- **Specific LEV Subsidies** – Under MOVES III, **L6e quadricycles** are eligible for up to **€1,600**, while **L7e quadricycles** qualify for up to **€2,000**, provided a scrappage condition is met[29].
- **Municipal Tax Relief** – Barcelona grants a **75% reduction in the annual vehicle tax (IVTM)** for zero-emission vehicles (including qualifying LEVs) registered in the city[30].
- **Low Emission Zone (ZBE) Access & Parking Benefits** – LEVs that meet zero-emission criteria receive **unrestricted access** to Barcelona's Low Emission Zone and are entitled to **free or reduced-rate parking** in regulated public zones[31].

These measures collectively create a supportive policy environment for adopting **electric quadricycles (L6e/L7e)** in Barcelona through 2025. Awareness of these benefits could be improved, and more targeted municipal-level grants or incentives for LEVs would further support their uptake.

[28] European Alternative Fuels Observatory (2025). *Spain extends MOVES III with €400 million for EVs.* https://alternative-fuels-observatory.ec.europa.eu/general-information/news/spain-extends-moves-iii-incentives-programme-eu400-million-boost-electric
[29] Latamobility (2025). *MOVES III: New incentives and tax deduction for EVs in 2025.* https://latamobility.com/en/moves-iii-program-spain-2025-new-incentives-for-electric-vehicles-and-charging-points/
[30] European Alternative Fuels Observatory (2025). *Spain – Tax benefits for zero-emission vehicles.* https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/spain/incentives-legislations
[31] Barcelona Secreta (2025). *Changes to green/blue zone parking for EVs.* https://barcelonasecreta.com/en/green-area-green-area-blue-area-parking-barcelona/

C. Annex: Extract from EDU + VCU Benchmark

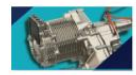
Competitor	SEG + Kalyani	SEG + x ?	TORK Motors + Kyalani	Virya Mobility	Varroc Bajaj affiliate	Mahindra Electric
Picture						
Motor type	3 Phase PMSM	3 Phase PMSM	Axial Flux Motor	IPM Motor	PMSM Motor	PMSM Motor
Voltage	48V / 96V	48V / 96V	NA	48V	48V	48V
Motor Power	Up to 9 kW	Up to 9 kW	NA	Up to 9.5 kW	Up 10 kW	Up to 8 kW
Motor Torque	NA	NA	NA	NA	36 Nm	42 Nm
Reducer	2 speeds, ratio NA	1 speed TBC	2 speeds, ratio NA	2 speeds, ratio NA	2 speeds, ratio NA	1 speed Ratio 12.15/13.8
IP	IP 67	IP 67	IP 67	IP 67	IP 67	IP 67
Cooling	Air cooled	Air cooled TBC	Air cooled	Air cooled	Air cooled	Air cooled
Selling Price	NA	27000 INR 300 euros	NA	38 000 INR 420 euros	27000 INR 330 euros	
3 Whl Customers	Small Players (Eblu, Grevol,..)	New Stellantis 3W	Small Players (OSM, Greaves)	Big Player : Piaggio Small Players : OSM, E-Trio	Big Player : Bajaj	Big player : Mahindra Electric
4 Whl Customers	Not known	New Gen Ami	Not known	Not known	Not known	Not known

Figure C-1: EDU + VCU benchmark on Indian market

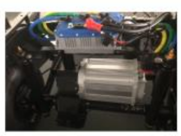
	Mingzun/Curtis/Jinhua	Mahle/Sevcon/Lingyue	KDS/HSLT/Lingyue	Mahle/Sevcon/Schaeffer
Picture				
Motor type	PMSM	ASM	ASM	ASM
Voltage	48V	48V	48V	48V
Motor Power	? kWp/5 kWc	9 kWp/5 kWc	? kWp/4 kWc	9 kWp/5 kWc
Motor Torque	75 Nm peak	80 Nm@1000rpm 35 Nm@2000rpm	12.7 Nm continuous	80 Nm@1000rpm 35 Nm@2000rpm
Reducer	Ratio 16	Ratio 12.25	Ratio 12.25 to 16	Ratio 17
Limited slip differential option	Yes	Yes	Yes	Yes
IP	IP 67	IP 67	IP 67	IP 67
Cooling	Air cooled	Air cooled	Air cooled	Air cooled
Selling Price	4244 CNY	6286 CNY	4360 CNY	NA
Golf Cart Customer	Alwayz	Columbia	Lvtong	Textron

Figure C-2: EDU + VCU benchmark on Indian market

D. Annex: Extract from Battery Benchmark

General information			Swappable Battery				Weight Price Information				Capacity and Price per Energy/Capacity			
System	Market	Application Focus	Swapping Methode	Tool	Picture of Swappabilty in Vehicle	Picture of Swapping in Cabinet	Weight of Single Module [kg]	Weight of Battery System [kg]	Price of Single Module [EUR]	Price of Multiple Modules [EUR]	Single Module Battery Capacity [kWh]	Single Module Battery Price per Capacity [EUR/kWh]	Multiple Modules Max. Battery Capacity [kWh]	Multiple Modules Max. Battery Price per Capacity [EUR/kWh]
Estrima Biro Battery System	Advanced market (Europe)		Yes	No		Not applicable	46	46	5900	5900	5,04	1171	5,04	1171
XEV YOYO Battery System	Advanced and Emerging Market (China)		Yes	Yes Battery Exchange Service			25	75	Not available	Not available	3,5	Not available	10,4	Not available
Silence Battery System	Advanced market (Europe)		Yes	No			40	80	Not available	Not available	5,6	Not available	11,2	Not available
Tojo Battery System	Emerging market (Philippines)		Yes	Portable lift truck	Not available	Not available	50	50	Not available	Not available	7,2	Not available	7,2	Not available
Tojo Battery System	Emerging market (Philippines)		Yes	Portable lift truck	Not available	Not available	45	45	Not available	Not available	6	Not available	6	Not available
Honda Swappable Battery System	Advanced Market (Japan)		Yes	No			12	48	700	2800	1,3	538	5,2	538
Piaggio Ape E-City Battery System	Emerging Market (India)		Partially	No			17,5	70	Not available	Not available	1,4	Not available	5,6	Not available
AES Battery System	Advanced and Emerging Market (China)		Yes	No	Not available		12	Not available	Not available	Not available	1,44	Not available	Not available	Not available
Torrot Battery System with Swobbee Station	Advanced Market (Spain)		Yes	No			20	Not available	900	Not available	3,7	243	Not available	Not available
GoGoro Battery System	Emerging Market (Taiwan)		Yes	No			11,5	Not available	750	Not available	1,3	577	Not available	Not available
Kumpan Eelectric Battery System with Swobbee Station	Advanced Market (Germany)		Yes	No			13	Not available	1400	Not available	2,4	583	Not available	Not available

Figure D-1: Battery Systems Benchmark and Charging Cabinet Solutions (pricing data insufficient)