URBANIZED D8.5: Definition of relevant business cases under different future scenarios

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Related Work Package	8
Version/Status	1.1 | Final
Issue date	28/06/24
Deliverable type	R
Dissemination Level	PU

Project Acronym	URBANIZED
Project Title	modUlaR and flexible solutions for urBAN-sIzed Zero-Emissions last-mile Delivery and services vehicles
Project Website	https://urbanized.eu/
Project Coordinator	Salvador Ruiz | IDIADA
Grant Agreement No.	101006943

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101006943.

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Version	Date	Reviewer (Name/Organisation)	Action (Checked/Approved)
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1.1	28.06.24	David Storer / CLEPA	Approved

Document history

Version	Date	Author(s)	Status*	Dissemination level**
1.1	20.06.24	Samuel Rouquette, Zisis Maleas	Draft	PU
2.1	28.06.24	Samuel Rouquette, Zisis Maleas	Final	PU
2.2	19.08.24	Samuel Rouquette, Ignacio Magallón	Final, addressing comments from EC	PU

*Status: Draft, Final, Approved, Submitted (to European Commission).

Dissemination Level: **PU: Public; **CO**: Confidential, only for members of the consortium (including the Commission Services); **EU-RES** Classified Information - restraint UE; **EU-CON**: Classified Information - confidential UE; **EU-SEC**: Classified Information - secret UE

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Keywords

Urban Logistics Vehicle; Total Cost of Ownership; Economic Assessment; Modularity.

Executive summary

The URBANIZED project has pioneered the next generation of modular vehicle architectures for urban commercial electric vehicles, setting new standards in design optimization and mission-specific functionality. This initiative has demonstrated innovative engineering and also addressed the practical needs of urban logistics through its three-dimensional approach:

- **Advanced powertrain technologies**: the project has developed high-performance e-powertrain components, using cutting-edge co-design approaches that significantly enhance the efficiency and reliability of electric vehicles. Innovations such as Gallium Nitride (GaN) semiconductors have achieved up to 98% efficiency in powertrain inverters, minimizing electrical losses and maximizing performance.
- **Modular cargo solutions**: URBANIZED has introduced interchangeable, plug-and-play cargo modules that can be swiftly adapted to a variety of urban freight transport scenarios. This flexibility allows for tailored solutions for different use cases, ranging from last-mile deliveries to on-demand urban services, enhancing the vehicle's usability across multiple sectors to reduce fleet sizes.
- **Fleet and energy management**: the project has integrated sophisticated energy and fleet management strategies, leveraging data analytics, connectivity, and learning algorithms to optimize operations.

Throughout the project, URBANIZED has maintained a holistic design philosophy, operating across system, vehicle, and fleet levels. Starting from the identification of specific mission profiles for key urban services, such as retail delivery and hospitality services, the project has engaged in continuous optimization loops to refine vehicle design and functionality.

The involvement of a diverse consortium of nine partners from six EU countries, including academic institutions, industrial players, and logistics operators, has enriched the project, ensuring a comprehensive approach to development and implementation. Significant partnerships with three satellite cities committed to CO2 emission-free logistics and a major OEM have further extended the project's reach and impact, showcasing its scalability and replicability. Recent achievements in safety, demonstrated through rigorous crash tests at Applus+ IDIADA, have provided data that will inform further enhancements in vehicle safety and performance, addressing the critical aspects of crashworthiness and occupant protection.

This deliverable aims to showcases how the URBANIZED vehicle meets economical expectations and growing demands for efficient and adaptable urban logistics solutions, while paving the way for future innovations in the electric-light commercial vehicle sector.

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1. Introduction

The transition to sustainable urban logistics is becoming increasingly critical in densely populated cities. Responding to this need, the URBANIZED project has developed a modular, energy-efficient urban logistics vehicle that addresses the economic and regulatory shifts in the transportation sector. Recent market dynamics reveal a significant rise in EV adoption, propelled by technological advancements and supportive policy frameworks. For example, although electric light commercial vehicles (e-LCVs) have gained traction in Europe due to favourable policies and growing corporate commitment to sustainability, the uptake is still lagging behind traditional options. In 2023, diesel-powered LCV registrations vastly outnumbered battery-electric models, with over 1.2 million diesels versus only 108,200 e-LCV registrations.

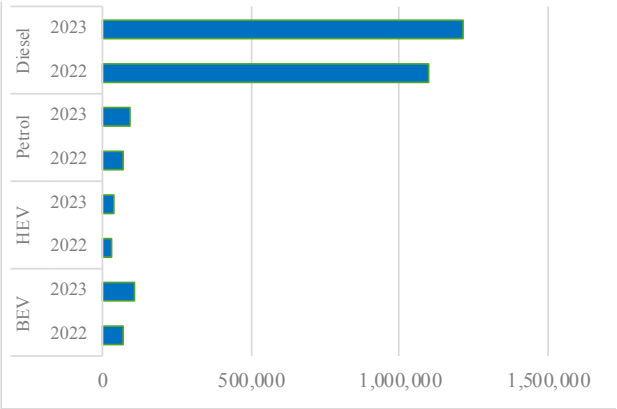

Figure 1: New LCV registrations by fuel type, 2023 (EAFO)

This gap highlights an opportunity for the URBANIZED vehicle to capitalize on the market by addressing reservations about adopting e-LCVs. By delivering a vehicle that meets high operational, environmental and safety standards, the project positions itself to leverage the ongoing shift toward more sustainable and efficient urban logistics solutions. The primary goal of this deliverable is to develop economic business cases for the various project solutions, defining roles within the local ecosystem of stakeholders and setting the base for attractive value propositions for future end-users and adopters of the URBANIZED products. The approach is to demonstrate the practical and economic applications of these innovations, focusing on real-world usability over theoretical market forecasts.

To provide a strategic analysis of the competitive landscape, the document first proposes a Porter's Five Forces analysis. This model assesses the market dynamics that impact the e-LCV industry, including the threat of new entrants, the bargaining power of suppliers and customers, the threat of substitute products, and the intensity of competitive rivalry. Understanding these forces helps to identify potential opportunities and threats, allowing the URBANIZED project to develop strategies to secure a competitive advantage and to better understand the LCV supply chain and structure.

Then, to analyse economic viability of the project-developed vehicle, this document will use a Total Cost of Ownership (TCO) tool to illustrate the economic advantages of the URBANIZED vehicle compared to traditional internal combustion engine vehicles. This analysis incorporates extensive data points, such as daily kilometres driven, energy consumption, and maintenance costs, to provide a clear view of the potential savings and benefits. Additionally, the document examines various use cases demonstrating the vehicle's modular design and eco-friendly technology. Applications such as urban delivery, municipal services, construction, and waste management will be explored, where the vehicle's capabilities can be fully appreciated.

Subsequent sections will include detailed scenario analyses, considering different environments, applications and fleet structures. These scenarios will illustrate how the URBANIZED vehicle can meet and

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adapt to evolving market conditions, providing a comprehensive framework for understanding its long-term viability and market potential.

2. Porter's Five Forces Analysis

2.1 Introduction

A key component in strategic analysis and business planning is Porter's Five Forces model. This framework is a thorough and systematic examination of the competitive landscape of an industry. The model, by examining five key drivers, assists companies in comprehending the market dynamics, identifying potential opportunities and threats, understanding how they can affect profitability, and crafting strategies to secure a competitive advantage (Aura, 2024).

As (Porter, 1997) framed it, the basic principle behind the model is:

> *"In the fight for market share, competition is not manifested only in the other players. Rather, competition in an industry is rooted in its underlying economics, and competitive forces exist that go well beyond the established combatants in a particular industry. Customers, suppliers, potential entrants, and substitute products are all competitors that may be more or less prominent or active depending on the industry."*

As depicted in Fig.2 the first force is the threat of new entrants defined by the barriers a company needs to overcome to enter the industry. The model also emphasizes the influence of both suppliers and buyers, assessing the nature of supplier power and buyer dependence.

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Figure 2: Forces governing competition in an industry

The threat of substitutes, influenced by the price-performance ratio of alternative products and the switching costs associated with these substitutes, is also one of the drivers. The fifth force is competitive rivalry. It evaluates the interactions and offerings of existing competitors, which are influenced by factors such as the number of competitors, industry growth, and barriers to entry and exit, as well as price competition.(Gratton, 2024) (Porter, 2008) (Porter, 1997) By determining the strength of the forces the model provides insights regarding the profit potential of an industry, as Porter (1997) explains:

> *"The collective strength of these forces determines the ultimate profit potential of an industry. It ranges from intense in industries like tires, metal cans, and steel, where no company earns spectacular returns on investment, toward mild in industries like oil field services and equipment, soft drinks, and toiletries, where there is room for quite high returns."*

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2.2 Implementation

The electric Light Commercial Vehicle (e-LCV) market is characterized by significant competitive forces that influence industry dynamics. Understanding these forces and their impact on the market can help manufacturers develop effective strategies to navigate challenges, leverage opportunities, and maintain a competitive advantage in the rapidly evolving electric vehicle industry.

2.2.1 Threat of new entrants

The threat of new entrants into the e-LCV market is moderated by several significant barriers:

- Capital requirements
  With respect to the threat of new entrants, it is important to consider that the electric vehicle industry, particularly for commercial vehicles, requires substantial capital investment. New entrants must invest in research and development (R&D), manufacturing facilities, and battery technology. Establishing a new electric vehicle production facility can cost billions of dollars due to the required infrastructure and technology investment. This high capital requirement acts as a significant barrier to entry and consequently lowers the threat of new entrants. (Dimitrakaki, 2020)(Fedotov, 2022)(Fildes et al., 2007)

- Technical know-how
  The electric vehicle market is heavily dependent on advanced techno-logical innovation. The well-established companies have invested heavily in developing their electric vehicle technology, including batteries, electric drivetrains, and software. The technological expertise needed to develop competitive e-LCVs is a barrier for new entrants without established R&D capabilities. (Zhang, 2023)(Cho and Shin, 2022)(Shu, 2022)

- Economies of scale
  Apart from that the already established companies benefit from economies of scale in production, allowing them to lower costs and offer competitive pricing. Large manufacturers like can produce electric vehicles at a lower cost per unit compared to new entrants due to their production volume and scale.(Dimitrakaki, 2020)(Fedotov, 2022)(Fildes et al., 2007)

- Brand loyalty
  Brand and reputation play an important role in the market, with companies like Mercedes-Benz and Ford benefiting from customer loyalty and trust. This brand loyalty makes it challenging for new entrants to gain market share quickly. (Cho and Shin, 2022)

- Access to critical components
  Securing a reliable supply chain for critical components like batteries and electric motors is essential for electric vehicle manufacturers. Established manufacturers secure long-term

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contracts with battery suppliers, giving them an advantage in securing critical components. (Zhang, 2023)

- Regulatory framework
  The automotive industry is heavily regulated, and compliance with safety, emissions, and other regulatory standards is costly and time-consuming. On the other hand, governments may also provide incentives for electric vehicle adoption, such as tax credits and subsidies, which can mitigate some of the regulatory barriers.(Shu, 2022)(Cho and Shin, 2022)

- Supply chain access
  New entrants may struggle to quickly establish relationships with dealerships, fleetoperators, and other distribution channels. On the other hand, established manufacturers have existing networks and partnerships which allow them to reach customers effectively. Building these relationships requires significant time and effort, limiting the market penetration of new entrants. (Zhang, 2023)(Cho and Shin, 2022)(Mu, 2023).

- Switching costs
  New entrants are slightly benefited from the relatively low switching costs, which are primarily associated with retraining staff and adapting to new vehicle specifications, and allow fleet operators to consider alternatives and switch between different e-LCV manufacturers based on pricing, features, and customer service.(Ninh, 2021)

- Network effects
  Network effects where the value of a product increases with the number of users, are less significant in the e-LCV market. e-LCVs primarily serve as transportation solutions for businesses and commercial fleets, and their value is derived from factors like efficiency, cost savings, andenvironmental benefits. This reduces the advantage of incumbents who benefit from established user networks

The threat of new entrants in the e-LCV market is low:

While the relatively low switching costs and the growing demand for electric vehicles offer opportunities for new players, the capital requirements and technological know-how pose significant barriers. Established manufacturers benefit from economies of scale and strong distribution networks, making it challenging for new entrants to gain a foothold. Therefore, while new entrants can enter the market, they need substantial investment and innovative strategies to compete effectively. A new entrant should focus on niche markets or under-served regions, leverage innovative technologies, and form strategic alliances to overcome entry barriers. Securing funding and developing unique value propositions will be crucial.

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2.2.2 Bargaining power of suppliers

Suppliers in the e-LCV market exert significant bargaining power due to the following factors:

1. Unique components
   Suppliers in the e-LCV market exert significant bargaining power with unique components like advanced batteries and electric drivetrains being highly differentiated and associated with key product characteristics like range and performance. The technology behind these components iscomplex and continuously evolving, making it difficult for manufacturers to find equivalent alternatives. Suppliers that offer cutting-edge technology, proprietary advancements, or superior-quality products stand out in the market, further enhancing their negotiating power.

2. Importance of quality / cost
   The quality and cost of components, especially batteries, are crucial for the performance and price competitiveness of e-LCVs (Fedotov, 2022). High-quality batteries ensure better vehicle range, longevity, and safety, which are essential factors for both consumer satisfaction and regulatory compliance. Conversely, cost-effective solutions are necessary to keep the overall vehicle price competitive in a market where initial purchase cost remains a significant barrier to widespreadadoption. Consequently, suppliers with a reputation for high-quality and cost-effective solutions have significant bargaining power.

3. Supplier size
   In addition, the bargaining power of suppliers in the e-LCV market is significantly influenced by their size and scale of operations. Large suppliers such as LG Chem, CATL, and Panasonic benefit from economies of scale in production, distribution, and research and development. These economies of scale allow them to offer competitive pricing and terms compared to smaller suppliers. Moreover, larger suppliers often have more financial resources and stability, enabling them to invest in cutting-edgetechnologies and expand their production capacities to meet the growing demand for e-LCVs. This givesthem a stronger negotiating position with e-LCV manufacturers, who rely on their scale and capabilities to ensure reliable supply chains and competitive pricing.

4. Supplier independence
   Suppliers of critical components in the e-LCV market also benefit from a degree of independence. Many of these suppliers serve multiple industries, including consumer electronics, energy storage, and renewable energy. This diversification reduces their dependence on any single market, including e-LCVs, and allows them to negotiate better terms with automakers. For example, suppliers like LG Chem and Panasonic can leverage their established relationships and demand from other industries to negotiate favourable pricing, contract terms, and investment in future innovations. This independence strengthens their bargaining power, as they are less susceptible to the cyclical nature of fluctuations within the e-LCV market.

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5. Concentrated market threats

   The market for key components such as batteries in the e-LCV market is dominated by a small number of large suppliers, including LG Chem, CATL, Panasonic, BYD, Samsung SDI, SK Innovation and a few others. This concentration of power allows these suppliers to influence pricing, terms, and innovation in the industry. Automakers have limited alternative suppliers to turn to, which enhances the oligopolistic suppliers' bargaining power. In addition, the established suppliers have economies of scale, advanced technology, and established relationships with automakers, which create barriers to entry for new suppliers.

6. Switching costs

   Many suppliers have established long-term contracts and relationships with major automakers. These contracts provide stability and predictability in the supply chain, but they also createa barrier to switching suppliers. Automakers rely on these relationships to ensure a steady supply of high- quality components, which generates switching costs associated with changing suppliers. Suppliers have, further, developed specialized technologies and manufacturing processes tailored to the needs of electric vehicles. Switching to a new supplier would require retooling production lines, adapting to different technical specifications, and potentially retraining personnel, consequently generating more switching costs. These switching costs can deter manufacturers from changing suppliers frequently.

7. Supplier replaceability

   Supplier replaceability is relatively high in the e-LCV market because of their expertise, production capacity, and industry influence. Suppliers with advanced technological capabilities and a strong focus on innovation are less dispensable. Their expertise in developing cutting-edge battery technologies, electric drivetrains, and other critical components makes it challenging for manufacturers to easily switch suppliers without compromising on product quality or performance.

8. Downstream integration

   On the other hand, suppliers have limited downstream integration into electric vehicle manufacturing. While the threat of downstream integration by battery suppliers into e manufacturing exists, it remains moderate due to the high barriers to entry and the strategic choices of suppliers to focus on their core competencies. This dynamic is somewhat balanced by the efforts of well-established manufacturers to vertically integrate their supply chains, thereby reducing dependency on external suppliers and enhancing their own competitive position. (Fedotov, 2022)

9. Alternative materials

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Ongoing research into alternative energy storage solutions like solid-state batteries, hydrogen fuel cells, and supercapacitors could alter the market dynamics. If these alternative solutions become cost-competitive and hence, commercially viable, they could provide e-LCV manufacturers with more options, thereby reducing the bargaining power of current lithium-ion battery suppliers. However, until such substitutes are widely adopted, the existing suppliers maintain a significant influence over the market.

The overall bargaining power of suppliers for the e-LCV market is moderate:

Suppliers in the e-LCV market hold substantial bargaining power, primarily due to the oligopolistic nature of the battery supply market, the differentiated nature of critical inputs, and the importance of quality and cost in the production of e-LCVs. Large suppliers like LG Chem, CATL, and Panasonic dominate the market, making it difficult for manufacturers to switch suppliers without incurring significant costs. However, the increasing number of suppliers and technological advancements may gradually reduce this power over time. Building strong relationships with multiple suppliers and investing in long-term contracts can potentially mitigate risks. While exploring alternative technologies and in-house development of key components can reduce dependency on dominant suppliers.

2.2.3 Bargaining power of customers

Customers in the e-LCV market have considerable bargaining power due to the following factors:

1. Price sensitivity
   Buyers in the e-LCV (electric Light Commercial Vehicle) market, particularly fleet operators and commercial businesses exhibit a high degree of price sensitivity. The initial purchase price of e-LCVs represents a significant portion of the total cost of ownership for fleet operators and commercial businesses. Compared to traditional internal combustion engine vehicles, e-LCVs generally have a higher upfront cost due to the cost of electric drivetrains, batteries, and associated technologies. Given the competitive nature of the e-LCV market and the availability of alternatives, such as hybrid vehicles or traditional ICE vehicles, buyers have the option to evaluate various offerings based on price and cost- effectiveness. Consequently, price competitiveness is a key factor in their purchasing decisions.

2. Buyer size
   Large fleet operators hold a significant share of the overall market demand for e-LCVs and often purchase e-LCVs in bulk quantities, which gives them considerable bargaining power. The volume of their orders allows them to negotiate discounts, favourable pricing terms, and service agreements with manufacturers.

3. Fiscal capacity

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Large organizations, with substantial financial strength and resources, in addition to their ability to commit to a significant volume of purchases also reduce the financial risk of the manufacturer and can even form long-term strategic partnerships with manufacturers, including collaborative efforts in research and development, co-investments in infrastructure, and commitments to future purchases. For all these reasons they can negotiate for better pricing, terms, and service agreements with electric vehicle manufacturers.

4. Buyer market concentration
   These few but large buyers, such as delivery companies, dominate the market for e-LCVs.

(a) Large fleet operators
In Europe, a significant portion of e-LCV purchases is made by large fleet operators and logistics companies. Companies like DHL, UPS, and Amazon have substantial fleet requirements and financial muscle.

(b) Governments and municipalities
European governments and municipalities are major buyers of e-LCVs, especially as they urgently push for greener transportation solutions to meet their environmental targets.

(c) Retail and delivery giants
Companies like Carrefour, Tesco, Aldi, and other large retailers with delivery services are increasingly investing in e-LCVs to meet sustainability goals and improve last-mile delivery efficiency.

This concentration increases their bargaining power over manufacturers (Fildes et al., 2007). However, the presence of medium and small-sized buyers helps to mitigate the risk of dependency and limited negotiating leverage for manufacturers. Medium-sized buyers that influence the market are:

- Interregional logistics providers
  Interregional logistics providers operate at a scale larger than local couriers but smaller than multinational logistics giants. They often manage fleets that travel between cities and regions within a country, providing a crucial link in the supply chain.

- Retail and e-commerce fulfilment
  Medium-sized retailers and e-commerce fulfilment companies like Zalando are increasingly adopting e-LCVs to support their delivery operations. These companies require vehicles that can navigate urban areas efficiently and comply with environmental regulations.

- Healthcare and pharmaceutical logistics
  Medium-sized logistics firms specializing in the transport of medical supplies and pharmaceuticals. They require reliable and clean transportation solutions to comply with health regulations and sustainability goals.

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- Construction and real estate
  Mid-sized construction companies and real estate developers that use e-LCVs for transporting materials and equipment to job sites.

- Waste management and recycling
  Medium-sized waste management and recycling companieslike SUEZ are transitioning to electric vehicles to reduce noise and air pollution in urban areas. These companies operate fleets that collect and transport waste and recyclables.

- Rental and mobility services
  Companies that provide vehicle rental and mobility services are also significant buyers of e-LCVs. These firms cater to both individual consumers and businesses looking for short-term and long-term rental solutions.

Small-sized buyers that influence the market are:

- Local delivery services
  Many local delivery services and small logistics companies are adopting e-LCVs to meet urban delivery needs and comply with low-emission zones. These businesses typically purchase smaller fleets but are numerous enough to impact overall demand.

- Small service providers
  Small tradespeople (like electricians, plumbers, and maintenance companies), and service providers are also turning to e-LCVs for their operational needs. These businesses may only need one or a few vehicles, but their collective demand is significant.

- Independent retailers and restaurants
  Small independent neighbourhood shops, cafes (such as Coffee Island) and local restaurants can invest in e-LCVs for their delivery and logistics needs, aiming to reduce their carbon footprint and improve efficiency in urban settings.

While the oligopoly threat from large buyers is significant, the presence of medium and small-sized buyers is crucial for maintaining a balanced and competitive e-LCV market in Europe. Their diverse demands and innovative approaches present a potential to drive market growth, support sustainability goals and help manufacturers address challenges associated with concentrated buying power.

5. Undifferentiated product
   e-LCVs are perceived as relatively undifferentiated by buyers,with many manufacturers offering similar features and functionalities. Buyers tend to focus more on price and service over specific product attributes, intensifying competition among manufacturers.

6. Buyer independence
   In the e-LCV market, a moderate buyer independence is facilitated, in the e-LCV market, by a growing number of electric vehicle options and the ability to compare features,

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pricing, and service offerings among manufacturers. This independence empowers buyers to select the manufacturer and model that best aligns with their specific operational needs, preferences, and budget considerations.

7. Tendency to switch
   The e-LCV market demonstrates a significant tendency for buyers to switch suppliers due to factors such as availability of alternatives, price sensitivity, technological advancements, and service quality considerations. However, switching costs and established relationships moderate this tendency.

8. Product dispensability
   While e-LCVs offer environmental and cost-saving benefits, many businesses choose ICE or hybrid vehicles for their fleets due to lower upfront costs and concerns about the current charging infrastructure for e-LCVs. Certain operational requirements, such as long-distance travel, heavy load capacity, or access to existing fuelling infrastructure, may favour ICE vehicles over e-LCVs. Consequently, product dispensability remains a critical consideration in the e-LCV market.

9. Upstream integration
   Fleet operators and commercial businesses have limited capability and incentive to produce their own vehicles. The automotive manufacturing process requires significant capital investment, infrastructure, expertise, manufacturing capabilities, and scale to achieve cost efficiencies. So, they choose to prioritize their core competencies, reducing the threat of upstream integration.

The overall bargaining power of customers for the e-LCV market is moderate:

Customers in the e-LCVmarket, especially large fleet operators and commercial businesses, wield considerable bargaining power. Their sensitivity to price and operational costs drives them to seek competitive pricing and favourable terms. The presence of large buyers who purchase in bulk further intensifies their power, as they can negotiate better deals. Nonetheless, the relatively high initial costs and moderate switching costs for e-LCVs can limit their ability to frequently change suppliers, providing some leverage to manufacturers. Offering superior customer service, flexible financing options, and customized solutions can attract and retain customers. While, building a brand reputation for reliability and cost-effectiveness will also enhance competitive positioning. The presence of medium and small-sized buyers is crucial for maintaining a balanced and competitive e-LCV market in Europe. Their diverse demands and innovative approach drive market growth, support sustainability goals and help manufacturers navigate challenges associated with concentrated buying power. Targeting these types of businesses could be a promising mitigating policy especially applicable for new joiners.

2.2.4 Threat of substitute products

The primary substitutes for e-LCVs include traditional internal combustion engine (ICE) light commercial vehicles, alternative-fuelled vehicles (including BEV, PHEV, H2, LPG, CNG, LNG), and non-

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vehicular alternatives such as cargo bikes for urban deliveries. ICE vehicles have long dominated the commercial vehicle market due to their established infrastructure, lower upfront costs, and wide availability. However, alternative-fuelled vehicles offer a middle ground, to enhance fuel efficiency and reduce emissions, making them viable alternatives. Additionally, cargo bikes and other non-vehicular solutions are increasingly being adopted for last-mile deliveries in urban areas, driven by the need to reduce traffic congestion and emissions.

ICE Light Commercial Vehicles ICE LCVs are still the favourite LCV option in Europe and pose a significant threat to e-LCVs due to their established market presence (as depicted in Fig.2), their wide refuelling infrastructure, and generally lower upfront costs. These vehicles have been the industry standard for decades, providing reliability, extensive range, and high load capacities. However, increasing regulatory pressures to reduce emissions and the growing emphasis on sustainability are challenging their dominance. Despite these pressures, advancements in ICE technology, such as improved fuel efficiency and lower emissions, continue to sustain their competitiveness as viable substitutes for e-LCVs.

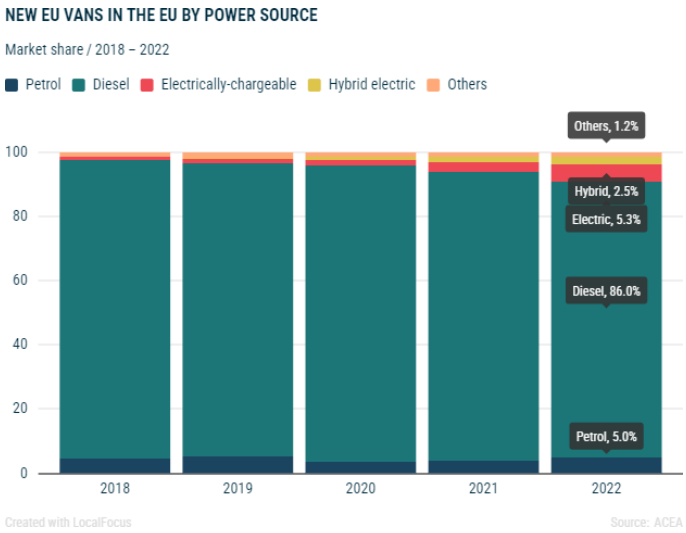

Figure 3: New EU van sales by power source (ACEA, 2023)

Alternative fuelled vehicles Alternative-fuelled vehicles, which Plug-in Hybrid Electric Vehicles (PHEV), Hydrogen (H2) fuel cells, Liquefied Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Liquefied Natural Gas (LNG) vehicles, represent significant potential substitutes for e-LCVs.

- **PHEVs** offer the benefits of both electric and gasoline power, extending the range and reducing emissions compared to traditional ICE vehicles. They can be particularly attractive in areas with limited charging infrastructure.
- **Hydrogen fuel cells vehicles** produce zero emissions and can offer long driving ranges and quick refuelling times. However, the limited refuelling infrastructure and high production costs currently restrict their widespread adoption.
- **LPG vehicles** are generally cheaper to run and produce fewer emissions than gasoline or diesel vehicles.They also benefit from an existing refuelling infrastructure in certain regions.

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- **CNG vehicles** offer lower emissions compared to traditional ICE vehicles and often have cheaper operational costs. Additionally, CNG refuelling infrastructure is already established in many regions, making it convenient for users.

- **LNG vehicles** provide a longer range compared to CNG vehicles and are suitable for heavy-duty and long- haul applications. They also emit fewer pollutants than diesel vehicles, making them more environmentally friendly.

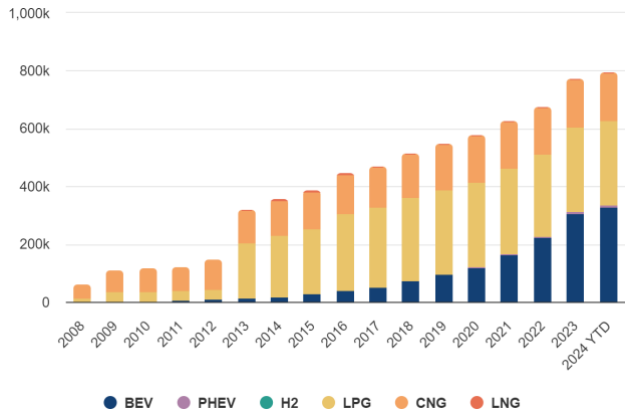

Figure 4: Total number of alternative fuelled (BEV, PHEV, H2, LPG, CNG, LNG) vans (N1) (EAFO, 2024)

The market share data depicted in Fig.3 and Fig.4 show varying degrees of adoption:

- **Battery Electric Vehicles (BEVs)**, classified as electric Light Commercial Vehicles (e-LCVs), have shown gradual growth in the Light Commercial Vehicle (LCV) sector. BEVs increased from 0.58% in 2021 to 1.02% in 2023, indicating a positive trend in adoption. This growth is driven by environmental regulations favouring zero-emission vehicles and the declining costs associated with electric vehicle technology.
- In contrast, **Plug-in Hybrid Electric Vehicles (PHEVs)** maintain a small and steady market share, ranging from 0.01% to 0.02% over the observed years. PHEVs offer lower emissions and better fuel efficiency than traditional vehicles, but they face competition from e-LCVs in terms of zero-emission operation and potential cost savings.
- **Hydrogen Fuel Cell Vehicles (H2)** continue to have negligible market share, remaining at 0% over the years due to infrastructure limitations and high costs. Despite offering zero tailpipe emissions and long-range capabilities, hydrogen vehicles struggle to compete with e-LCVs in terms of cost efficiency and refuelling infrastructure development.
- **Liquefied Petroleum Gas (LPG)** vehicles have shown stability, maintaining a market share of around 1% across the years. LPG vehicles benefit from established refuelling infrastructure and lower greenhouse gas emissions, making them a viable alternative for reducing operational costs in certain regions.
- **Compressed Natural Gas (CNG)** vehicles have also maintained a stable market share, ranging from 0.54% to 0.57%. CNG vehicles offer lower emissions and cost efficiency, supported by established infrastructure, which makes them a moderate threat to e-LCVs in the LCV sector.
- **Liquefied Natural Gas (LNG)** vehicles continue to have a minimal market presence, remaining

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at 0% through the years due to infrastructure limitations and higher costs than traditional fuels.

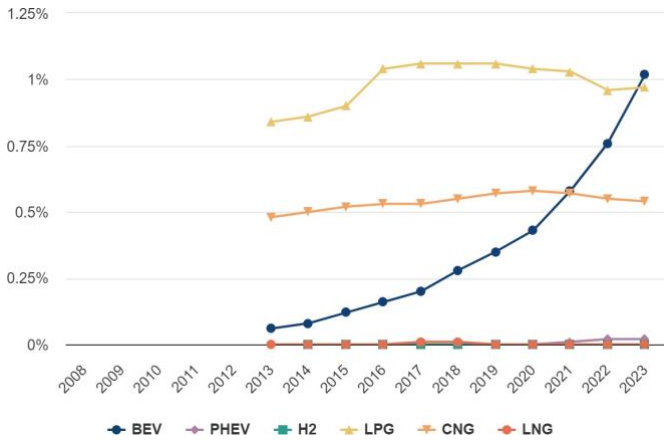

Figure 5: Fleet of alternative fuelled (BEV, PHEV, H2, LPG, CNG, LNG) vans as a percentage of the total fleet (EAFO, 2024)

Compressed Natural Gas (CNG) vehicles pose a moderate threat due to lower emissions, cost efficiency, and established infrastructure. Plug-in Hybrid Electric Vehicles (PHEVs), Hydrogen Fuel Cell Vehicles (H2), Lique- fied Petroleum Gas (LPG) vehicles, and Liquefied Natural Gas (LNG) vehicles face challenges including limited market share, infrastructure limitations, and higher costs compared to e-LCVs. The competitive landscape will continue to evolve based on technological advancements, regulatory changes, and infrastructure development in the future. In conclusion, while e-LCVs (BEVs) lead in terms of zero-emission capability and cost efficiency, Alternative Fuelled Vehicles collectively pose a moderate threat due to their varying levels of emissions reduction, cost efficiencies, and operational benefits compared to traditional and electric vehicles.

Non-vehicular alternatives Non-vehicular alternatives, like cargo bikes and electric scooters, are emerging as effective substitutes for e-LCVs, especially in densely populated urban areas. These alternatives are particularly suitable for last-mile deliveries, offering significant cost savings, ease of manoeuvrability, and reduced environmental impact. Cities implementing stringent emissions regulations and developing bike-friendly infrastructure are accelerating this shift. Although these alternatives are not suitable for all types of deliveries, their growing adoption in urban logistics highlights their potential to disrupt traditional light commercial vehicle markets for specific applications.

The e-LCV market faces a moderate to high threat of substitutes because traditional ICE vehicles and alternative-fuelled vehicles offer comparable benefits in terms of range, reliability, and refuelling infrastructure. In addition, conventional ICE vehicles are often cheaper upfront than electric vehicles due to the cost of battery technology and infrastructure. This price differential can sway buyers towards ICE options. Additionally, non-vehicular alternatives, while not universally applicable, are becoming more prevalent in urban areas for specific delivery needs. On the other hand, the switching costs for commercial buyers to transition from ICE vehicles to electric vehicles are relatively low if they already have the infrastructure and training in place. For an e-LCV manufacturer, emphasizing the total cost of ownership savings and environmental advantages of e-LCVs can differentiate them from substitutes. It is also crucial

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to innovate continuously to enhance performance, range, and charging infrastructure, thereby differentiating their products and reducing the attractiveness of substitutes.

2.2.5 Rivalry among existing competitors

Rivalry among existing e-LCV manufacturers is intense due to several factors:

- **Competitor size**
  Large manufacturers, such as Volkswagen, Mercedes-Benz and Renault-Nissan-Mitsubishi dominate the market due to their production capacity, brand recognition, and financial resources. The presence of large competitors intensifies rivalry as they aggressively pursue market share through extensive marketing campaigns, technological innovation, and strategic partnerships. Those partnerships, include strategic contracts with large fleet operators and logistics companies which ensure stable revenue streams, enhance market penetration and brand loyalty, enable economies of scale and provide manufacturers with valuable feedback on vehicle performance, reliability, and durability. Peugeot and Citroën, brands under Stellantis, have established a longstanding partnership, providing electric vans like the Peugeot e-Expert and Citroën ë-Jumpy for mail and parcel delivery as well as with Ayvens (Manthey, 2024), major fleet management company.

Similarly, Renault has partnered with, La Poste, the French postal services, to supply electric Kangoo Z.E. vans for mail and parcel delivery (Stijn, 2022), as well as with GEODIS, a major logistics company (GEODIS, 2022). While, Nissan is supplying the electric NV200 vans to Chronopost, a French express parcel delivery company and to DPD a major parcel delivery service operating across Europe (Nissan, 2020). Volkswagen is providing the e-Crafter to DHL for last-mile de- liveries in urban areas (Zprava, 2021). Ford has also partnered with DHL Express in the UK, DPD, and the Norwegian Post providing them the e-Transit (FORD, 2021). Large manufacturer's, ability to scale production and meet large orders gives them a competitive edge over smaller manufacturers. This size advantage increases competitive intensity.

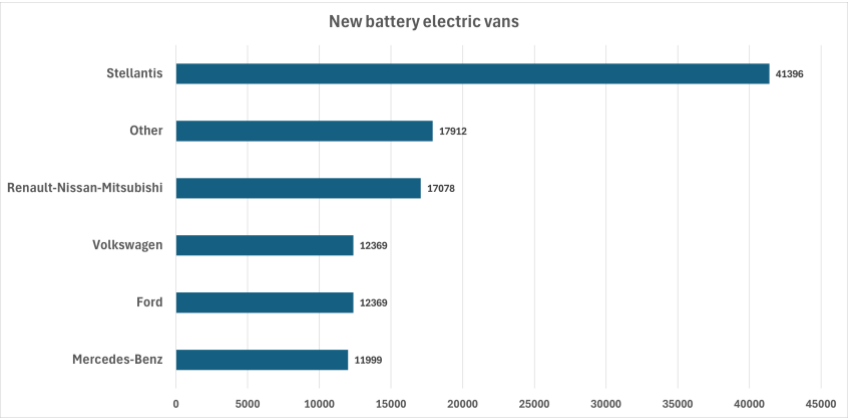

Figure 6: Battery electric vans sold in Europe by manufacturer pool, 2023 (Monteforte et al., 2024)

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- **Competitor diversity**
  The e-LCV market covers a wide range of competitors, including startups like Rivian, Bollinger Motors, and Arrival, as well as traditional automakers such as Ford, Renault, and Mercedes-Benz. This diversity of competitors in the e-LCV market increases competitive pressure, with both startups and established automakers competing for market share by introducing new technologies, improving product offerings, and targeting specific market segments. (Dimitrakaki, 2020)

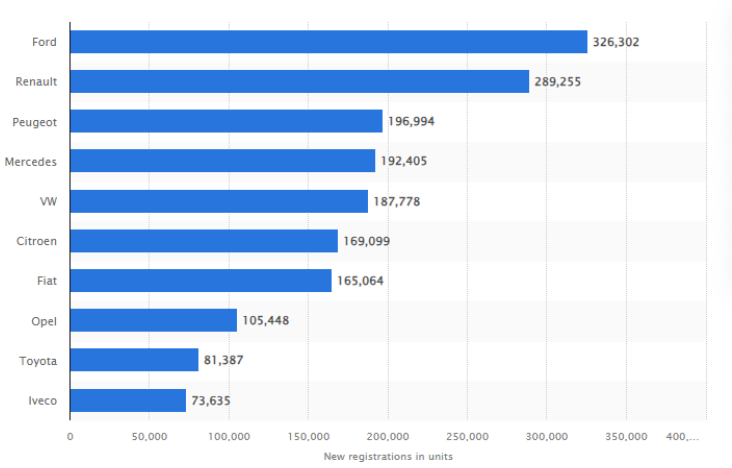

Figure 7: Best-selling light commercial vehicle brands in the European Union in 2021, based on new registrations (Statista, 2023)

- **Undifferentiated product**
  Many e-LCVs share similar technical specifications, such as range, payload capacity, and charging times, making them appear undifferentiated to buyers. In a market where products are perceived as undifferentiated, manufacturers often engage in price competition to attract buyers. This competitive pressure can lead to lower profit margins and reduced profitability for manufacturers as they strive to gain market share.

- **Exit barriers**
  Manufacturing e-LCVs requires specialized equipment and infrastructure, including advanced robotics, battery assembly lines, and electric drivetrain production facilities. Developing and maintaining expertise in electric vehicle technology, such as battery management systems and electric drivetrains, requires significant investment and time. These reasons, make it difficult for firms to leave the market, even when facing financial difficulties or declining demand. (Fedotov, 2022)

- **Growth feasibility**
  With a rising global demand for electric vehicles, driven by environmental regulations,

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government incentives, and increasing consumer awareness of sustainability, as well as continuous advancements in electric vehicle technology, including improvements in battery technology, range, and charging infrastructure, firms can expand production and market share relatively easily. However, this ease of expansion also intensifies competition among manufacturers. (Dimitrakaki, 2020)

- **Zero sum game**
  The e-LCV market is becoming increasingly crowded with a growing number of manufacturers entering the space. At the same time, the dependence on regulations and policies that may not be sufficient to rapidly accelerate market growth, and inadequate charging infrastructure can limit the practicality and appeal of electric vehicles, particularly for commercial applications. Theseconditions of a saturated market where demand growth is limited shape the zero-sum nature of the market, meaning that gains by one manufacturer often come at the expense of others.

- **Warehousing costs**
  Storage costs for e-LCVs, such as those related to batteries and other components, are relatively low compared to other types of commercial vehicles, reducing the pressure to sell quickly and allowing manufacturers to manage inventory levels more effectively.

The overall rivalry among existing competitors in the e-LCV market is moderately high:

Major players like Tesla, Rivian, and Ford, along with numerous startups, contribute to a highly competitive environment. The key factors contributing to this rivalry include the size of competitors, high exit barriers, and the perception of undifferentiated products. These factors suggest that firms will compete aggressively on price and features. Competitor diversity and ease of expansion also contribute to the competitive dynamics, though they offer both challenges and opportunities. Lower storage costs slightly alleviate the pressure, reducing the intensity of rivalry. Manufacturers compete on price, technology, and customer service to capture market share. As the market matures, differentiation through innovation and strategic partnerships will be crucial for sustaining competitive advantage and profitability. To secure a competitive advantage an e-LCV manufacturer should focus on unique technological innovations, superior after-sales service, and strategic partnerships. Additionally, targeting specific segments can reduce direct competition with the established giants.

2.2.6 Overall market dynamics

In analysing the electric Light Commercial Vehicle (e-LCV) market through Porter's Five Forces, the industry dynamics are shaped by the **low threat of new entries (2), moderate bargaining power of suppliers (3.1)**, **moderate bargaining power of customers (3)**, **moderate to high threat of substitutes (3.25)**, and **moderate to high rivalry among competitors (3.2).**

Table 1: Porter's Five Forces Strength for the e-LCV industry

Force	Quantitative	Qualitative
Threat of new entrants	2,20	**Low**
Bargaining power of suppliers	3,10	**Moderate**

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Bargaining power of customers	3,00	**Moderate**
Threat of substitute products	3,25	**Moderate-high**
Rivalry among existing competitors	3,20	**Moderate**
Overall average	2,84	**Moderate**
Threat of new entrants	2,20	**Low**

The high capital requirements and technological expertise needed pose an obstacle to new entrants. While new entrants are expected, the rapid market growth is outpacing the entry of new players, existing players have significant advantages in terms of market presence, economies of scale, brand loyalty, strategic contracts with large fleet operators and technological leadership.

Established suppliers of critical components like batteries wield considerable influence. Large fleet operators drive strong customer bargaining power due to their size and price sensitivity. Substitute products, such as traditional ICE vehicles, pose a credible threat, and com- petition among existing e-LCV manufacturers is intense. Potential opportunities lie in leveraging technological advancements and economies of scale, while threats include dependency on specialized suppliers and strong competition from traditional and hybrid vehicles. One should focus on innovation, cost efficiency, and building strong brand loyalty to affect profitability.

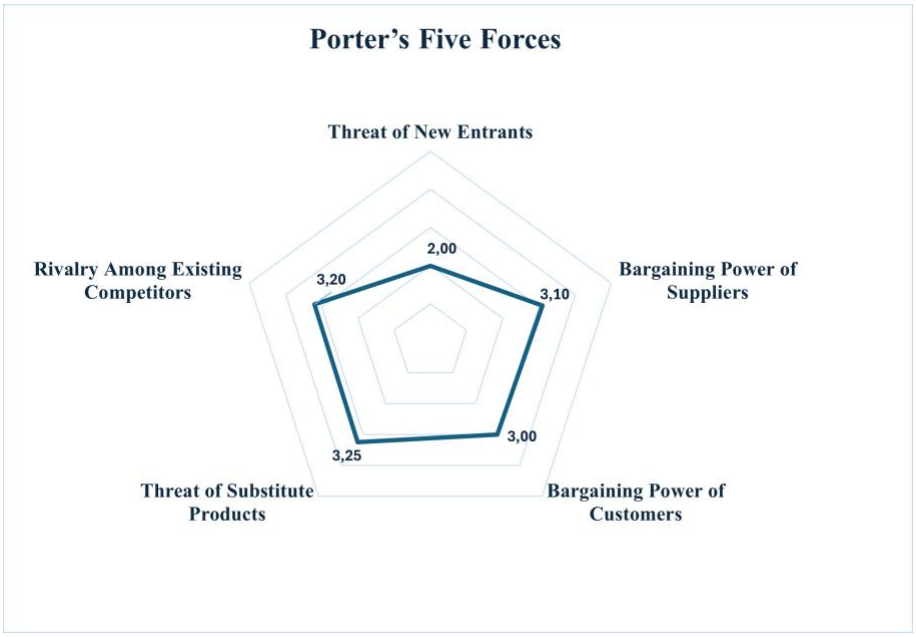

Figure 8: Porter's Five Forces for e-LCVs presented in Radar Chart

Strategies for securing a competitive advantage include investing in technological innovation to enhance product differentiation, developing strong relationships with key suppliers to ensure a stable supply of critical components, targeting specific market segments like medium and small-size buyers, leveraging

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economies of scale to reduce production costs and offer competitive pricing, and continuously improving customer service, while building loyalty to reduce switching tendencies.

Having established the competitive landscape through Porter's Five Forces analysis, which highlighted significant barriers to entry, the moderate bargaining power of both suppliers and customers, the credible threat from substitute products, and the intense rivalry among existing competitors, it becomes evident that robust economic strategies are essential for e-LCV solutions to thrive.

Economic strategies are crucial because the adoption of e-LCVs is heavily influenced by their total cost of ownership (TCO). Despite higher initial purchase prices, e-LCVs can achieve cost parity or even cost savings over time compared to internal combustion engine (ICE) vehicles. This is due to lower running costs, reduced maintenance expenses, and fiscal incentives aimed at promoting sustainable transport (Lebeau et al., 2019). Furthermore, economic analyses, such as those conducted using the TCO tool, are critical in demonstrating these long-term savings to potential adopters and stakeholders, thereby addressing the reservations about the higher upfront costs of e-LCVs.

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The next section of the document leverages the TCO tool to provide a comprehensive economic evaluation of the URBANIZED vehicle. Comparing the costs associated with the URBANIZED vehicle to traditional ICE vehicles should help highlight the economic benefits and savings over the vehicle's lifecycle.

The TCO tool should demonstrate cost efficiency but also emphasize the practical applications of the URBANIZED vehicle across the two main project use cases, namely Coffee Island and BPost. These scenarios will result in two main TCO analysis, comparing the associated costs of using the URBANIZED vehicle to using an ICE counterpart.

3. Total Cost of Ownership Analysis

3.1 Introduction

Numerous studies have explored the economic advantages of electric vehicles (EVs) compared to their diesel or petrol counterparts. For economic evaluations, researchers typically employ a Total Cost of Ownership (TCO) approach. This method accounts for all expenses associated with owning, operating, and maintaining a vehicle, making it a widely accepted measure of economic viability.

When assessing TCO for vehicles, different models from various manufacturers are usually compared. This comparison is particularly common in studies focusing on logistics vehicles, aiming to evaluate different vehicle sizes, user profiles, and drive technologies. For example, a TCO analysis in Germany indicated that without government subsidies, only full and mild hybrid electric vehicles are economically feasible for some user categories (Bubeck et al., 2016). Morrison et al. (2018) extended this approach by estimating the TCO for various light-duty vehicle segments defined by driving range and size class. Similarly, Lebeau et al. (2019) compared different electric light commercial vehicles (e-LCVs) and found that only smaller electric vans, including the Alke baseline vehicle (ATX 340e), which require less expensive batteries, are competitive with their conventional versions.

Several factors influence TCO results and must be carefully considered. The key economic factors are fuel prices, cost of vehicles and batteries cost, which are significantly impacted by production economies of scale (Lebeau et al., 2015; Levay et al., 2017). Additionally, government policies, such as financial incentives, can greatly enhance the competitiveness of EVs. For instance, Norwegian researchers identified several types of incentives in Norway such as tax exemptions, road tolls exemptions, along with reductions in vehicle license fees and benefits like free parking and bus lane access. Norwegian EV owners particularly value these incentives for reducing purchase costs. Langbroek et al. (2017) noted that incentives like free parking and bus lane access are effective alternatives to costly subsidies.

Comparing EVs and ICEVs using TCO is needed regarding their direct competition but must account for various factors that can change over time, such as fuel and energy prices, making pre-emptive evaluations challenging. These complexities show how important are region-specific TCO analyses to accurately assess the economic viability of e-LCVs in their respective locations and environments, which is the approach the URBANIZED project has chosen to showcase the economic viability of the developed vehicle.

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3.2 Data & methodology

In the case of our analysis, we focus on the two primary use cases for the URBANIZED vehicle: BPost in Brussels, Belgium, and Coffee Island in Thessaloniki, Greece. These use cases span different countries and logistics segments—postal and courier services versus HoReCa (Hotel, Restaurant, and Café). Given the distinct operational environments, each city presents unique cost factors impacting the Total Cost of Ownership (TCO).

For instance, in Brussels, the BPost analysis considers local policies, road tolls, and urban infrastructure, which differ significantly from those in Thessaloniki, where Coffee Island operates. Studies have shown that city-specific factors such as energy prices, insurance costs, and maintenance expenses can greatly influence the economic viability of electric vehicles. In our case, data regarding incentives are sourced from the European Alternative Fuel Observatory. Regarding fuel and electricity prices, estimations are based on local providers and checked against similar state-of-the-art studies. Fleet and routing data such as daily driven distance and fleet size are sourced from the impact assessment simulations (D7.1).

By tailoring the TCO analysis to each city, we aim to ensure a realistic and accurate assessment of the URBANIZED vehicle's economic benefits. This should allow us to account for the variability in costs and incentives that can affect the adoption and operational efficiency of e-LCVs.

3.2.1 Travel data

For the URBANIZED vehicle analysis, travel data is tailored to the specific operational patterns of BPost in Brussels and Coffee Island in Thessaloniki.

In Brussels, BPost operates within the city centre, conducting daily postal and courier deliveries. The analysis assumes 260 working days per year, with an average daily travel distance of 70 kilometres. This estimation is based on operational data and interviews with BPost, reflecting the typical delivery routes and distances covered within the urban environment of Brussels.

Similarly, for Coffee Island in Thessaloniki, the vehicle operates within the HoReCa sector, delivering supplies to various hotels, restaurants, and cafes across the city. The analysis also assumes 260 working days per year, with an average daily travel distance of 147.7 kilometres. This figure is derived from Coffee Island's logistics data, accounting for the frequent and short trips typical in the food and beverage delivery segment.

3.2.2 Vehicle data

Two models were chosen to accurately reflect the costs associated with their features. The e-LCV model is represented by the URBANIZED vehicle, and its internal combustion engine vehicle (ICEV) counterpart is the diesel version of a similar vehicle already widely used and sold in Europe, the Renault Kangoo in its Diesel version. Both vehicles are assumed to have been purchased on January 1, 2024, to align with the project timeline.

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The analysis includes parameters such as vehicle power, urban fuel and electricity consumption, purchase price, and depreciation rate. These parameters are essential for determining both initial and ongoing costs. The purchase prices were sourced directly from manufacturer websites for and from the expected retail price of the URBANIZED vehicle, as described in the project proposal. Depreciation rates help calculate the residual value of the vehicles at the end of the ownership period, with EVs typically having slightly lower depreciation rates compared to ICEVs (Lebeau et al., 2015).

For the URBANIZED vehicle, the maximum power is 14 kW, with an electricity consumption rate of 10 kWh per 100 kilometres. The purchase price is €36,000 (including two cargo bodies) in both Greece and Belgium, with a depreciation rate of 17.25% per year, resulting in a residual value of €7.915 after eight years.

For the ICE vehicle counterpart, the maximum power is 70 kW, and it has an urban fuel consumption of 5.5 litres per 100 kilometres. This vehicle's purchase price is €26,462 in Belgium and €24,597 in Greece, with a depreciation rate of 18.57% per year, yielding a residual value of €4,523 and €5.416, respectively, at the end of the ownership period. These vehicle specifications form the basis for calculating operational costs, including registration fees and fuel or electricity costs, which are essential for the TCO analysis.

3.2.3 Cost data

One should consider various cost factors specific to each city. For both cities, a registration fee is required upon vehicle purchase for ICE vehicles, influenced by the vehicle's power and emissions. Electric vehicles benefit from significant government subsidies, estimated at €8,000 in Greece and €5,000, which are included in the analysis

Fuel and electricity costs, crucial for the TCO calculation, are based on local prices in Brussels and Thessaloniki. Insurance premiums are derived from the top three providers in each city, with electric vehicles enjoying a roughly 30% discount compared to their diesel counterparts. In Greece, the average annual insurance cost for a BEV N1 vehicle is approximately €900, while for a diesel N1 vehicle, it is around €1,200. In Belgium, the yearly insurance cost for a BEV N1 vehicle is about €1,100, and for a diesel N1 vehicle, it is approximately €1,500. These costs are assumed to remain constant over the ownership period.

Table 2: Cost elements for the BPost use case

Cost type	URBANIZED	ICE
Registration fee (base amount) [€]	0	150.81
Subsidies	5000	0
Feeding [€/u.o.m]	0.16	1.70
Feeding cost [€/year]	366.08	1364
Insurance [€/year]	1100	1150
Maintenance and repair [€/km]	0.0344	0.0563
Maintenance and repair [€/year]	307	999.84

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Sources: National sources (registration fees), EAFO (subsidies), switcher.io & local energy providers (feeding costs), ING (insurance costs), Scorrano et. al, 2021 & local insurance providers (maintenance and repair costs)

Table 3: Cost elements for the Coffee Island use case

Cost type	URBANIZED	ICE
Registration fee (base amount) [€]	0	98
Subsidies	8000	0
Feeding [€/u.o.m]	0.23	1.621
Feeding cost [€/year]	1016.6	2271.669
Insurance [€/year]	900	1200
Maintenance and repair [€/km]	0.0281	0.0469
Maintenance and repair [€/year]	307	1195.012

Sources: National sources (registration fees), EAFO (subsidies), switcher.io & local energy providers (feeding costs), ING (insurance costs), Scorrano et. al, 2021 & local insurance providers (maintenance and repair costs)

3.2.4 Ownership

The period of ownership is a critical parameter in calculating the Total Cost of Ownership (TCO). This timeframe affects how operational costs are spread out and evaluated over the vehicle's lifespan. For this analysis, an ownership period of 8 years is used, aligning with the European Environment Agency's recommendations.

In addition to the ownership period, a discount rate is essential to consolidate costs incurred over different years into a single present value. The discount rate, often described as the rate of interest reflecting the investors' time value of money and is applied to account for the diminishing value of money over time.

For our TCO analysis, the selected discount rate is 1.29% for electric vehicles (EVs) and 0.82% for internal combustion engine vehicles (ICEVs). These rates are based on market conditions and reflect the differing economic dynamics between EVs and ICEVs.

In the context of the BPost and Coffee Island use cases, these ownership and discount rate parameters are applied to accurately compute the TCO for both the URBANIZED vehicle and its ICEV counterparts. This should ensure a fair comparison by accounting for the time value of money and the operational lifespan of the vehicles.

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3.2.5 TCO formula

The TCO formula used in this analysis is adapted from the state-of-the-art model presented by Siragusa et al. (2020), tailored to the specific conditions and data available for our use cases in Brussels and Thessaloniki.

The TCO function is expressed as follows:

$$TCO_T = PP_0 - RV_T + RFC_0 - S_0 + \sum_{t=0}^{T} \frac{FC_t + IC_t + MRC_t + BC_t + OC_t + RT_t - II_t}{(1+i)^t}$$

Where:

- TCO_t is the Total Cost of Ownership for the vehicle.
- PP_0 is the purchase price of the vehicle at the start of the ownership period.
- RFC_0 is the cost of the registration fee
- RV_t is the residual value of the vehicle at the end of the ownership period.
- S_0 is the subsidy received at the time of vehicle purchase.
- FC_t represents the fuel or electricity costs in year t.
- IC_t is the insurance cost in year t.
- MRC_t denotes the maintenance and repair costs in year t.
- OC_t refers to the ownership costs, such as taxes, in year t.
- BC_t indicates the battery replacement costs for electric vehicles in year t (not applicable as its longevity outpaces the total ownership period).
- RT_t covers road tolls and other fees in year t.
- S_0 is the subsidy received at the time of vehicle purchase.
- i is the discount rate.
- II represent indirect incentives
- T is the total ownership period, in years.

Each cost component is calculated based on local data and the specific operational conditions of the vehicles in both Brussels and Thessaloniki. The discount rate (iii) is applied to convert future costs into present value terms, reflecting the time value of money. This guarantees that the TCO reflects real economic load over the entire ownership period.

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3.3 Results

3.3.1 Vehicle level: Coffee Island use case results

The Total Cost of Ownership (TCO) analysis for the URBANIZED vehicle and its internal combustion engine vehicle (ICEV) counterpart in the Coffee Island use case provides a detailed comparison of the economic viability of each vehicle type in an urban logistics environment.

Main costs in the TCO analysis include recurring annual expenses such as fuel or electricity, insurance, maintenance, and repair costs. These operational expenditures are indispensable as they reflect the everyday running costs of the vehicle. Total TCO goes beyond these main costs to include the initial purchase price, registration fees, and any subsidies received. It also factors in the vehicle's residual value at the end of its ownership period, providing a full vision of the economic impact over the vehicle's lifetime.

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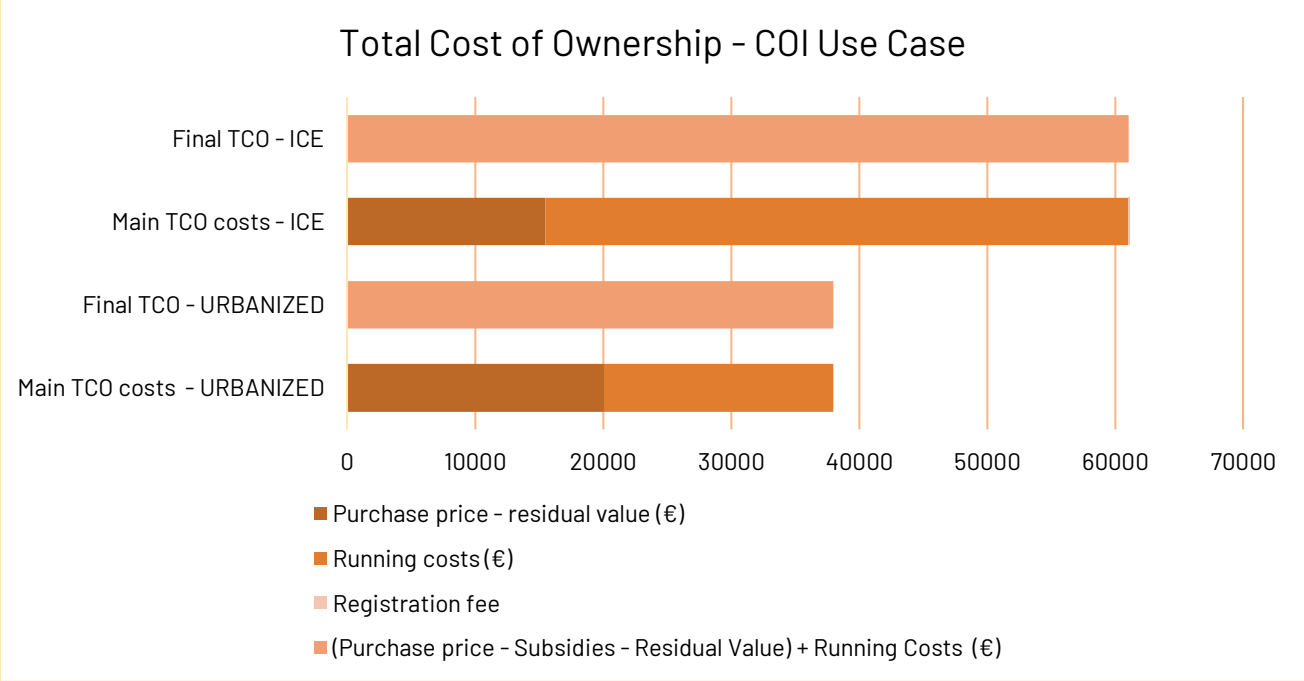

Figure 9: TCO results - Coffee Island use case

For the URBANIZED vehicle, the total TCO over an 8-year period is €41,176.15, compared to €61,045.67 for the diesel vehicle. This significant difference underscores the economic advantages of the electric light commercial vehicle (e-LCV) over its diesel counterpart.

Breaking down the costs, the yearly feeding costs for the URBANIZED vehicle are substantially lower, at €1,016.60 compared to €2,271.67 for the ICEV. This is mostly due to the lower cost of electricity versus diesel fuel. Insurance costs are strengthening the URBANIZED vehicle, with annual premiums of €900 compared to €1,200 for the diesel vehicle. Maintenance and repair costs also demonstrate the advantage of the URBANIZED vehicle, with a value of €307 in contrast to €1,195.01 for the ICEV. The absence of ownership costs for the URBANIZED vehicle also contributes to its lower overall TCO.

Looking at the cumulative costs over the ownership period, the feeding costs for the URBANIZED vehicle total €9,149.40, while those for the ICEV reach €18,173.36. Insurance costs for the URBANIZED vehicle accumulate to €8,100, compared to €9,600 for the ICEV. Maintenance and repair costs over the 8 years amount to €2,763 for the URBANIZED vehicle and €9,560.10 for the ICEV.

The division of costs illustrates the economic burden each vehicle type places on Coffee Island's operations. For the URBANIZED vehicle, the division values for each year gradually increase from €2,223.60 in the first year to €2,466.99 in the eighth year, resulting in a total division value of €21,091.07. For the ICEV, these values range from €4,666.68 in the first year to €5,177.49 in the eighth year, culminating in a total division value of €39,597.26.

Ultimately, the final TCO for the URBANIZED vehicle is €41,176.15, while the ICEV stands at €61,045.67. This shows that, despite the higher initial purchase price of the electric vehicle, its lower operational and

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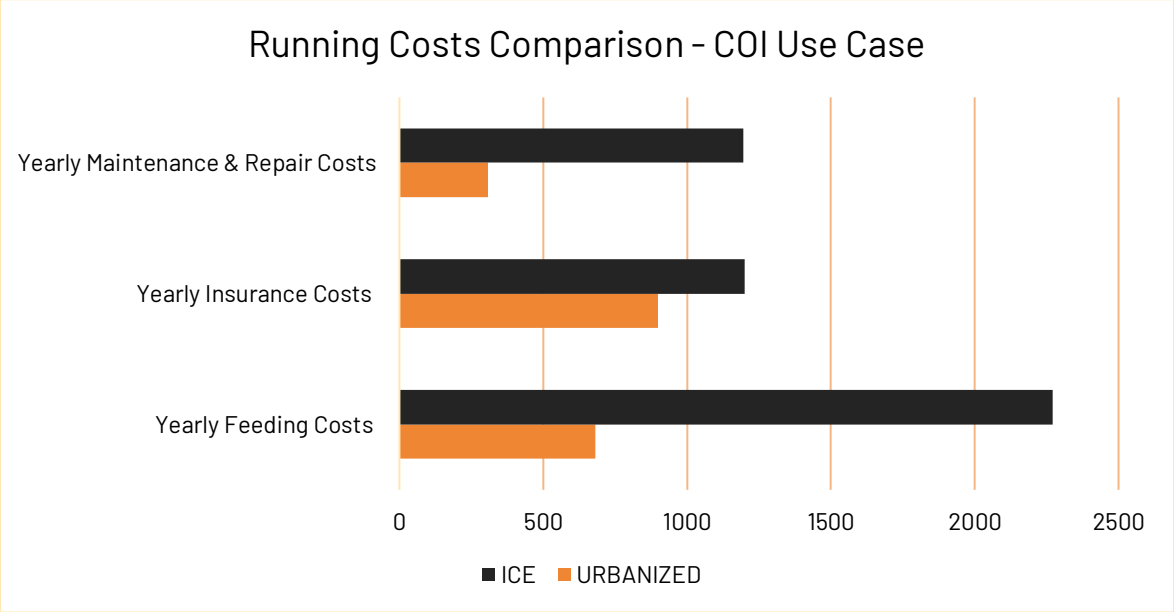
maintenance costs, coupled with favourable insurance premiums and the absence of ownership taxes, make it a more cost-effective option over the long term for urban logistics applications like those of Coffee Island in Thessaloniki.

Figure 10: Running Costs comparison: COI use case



3.3.2 Vehicle level: BPost use case results

Over an 8-year ownership period, the URBANIZED vehicle incurs a total TCO of €43,459.83, whereas the ICEV totals €51,528.62. This significant difference stresses the financial advantages of the electric vehicle over the diesel-powered counterpart.

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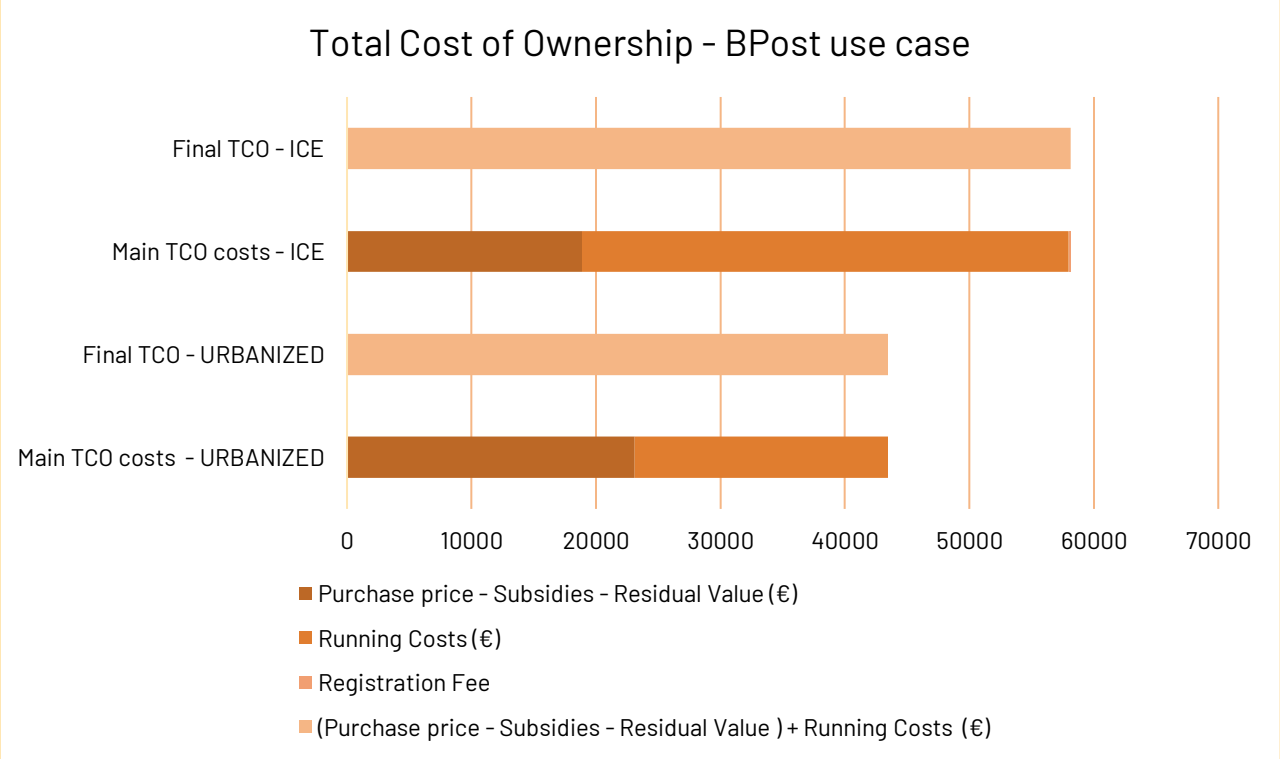

Figure 11: TCO results - BPost use case

Looking at annual expenses, the feeding costs for the URBANIZED vehicle are significantly lower, at €366.08 per year, compared to €1,496 for the ICEV. This is primarily due to the lower cost of electricity relative to diesel fuel. Additionally, the insurance costs are more favourable for the URBANIZED vehicle, with annual premiums of €1,100 compared to €1,150 for the diesel vehicle. Maintenance and repair costs further highlight the benefits of the URBANIZED vehicle, with annual expenses of €307 against €999.84 for the ICEV. The electric vehicle also avoids ownership costs, contributing to its lower overall TCO.

When these costs are aggregated over the 8-year period, the feeding costs for the URBANIZED vehicle total €3,661, whereas those for the ICEV reach €11,968. Insurance costs for the URBANIZED vehicle accumulate to €8,800, compared to €9,200 for the ICEV. Maintenance and repair costs over the ownership period amount to €2,763 for the URBANIZED vehicle and €7,998.72 for the ICEV.

Analysing the cost per kilometre driven, the URBANIZED vehicle operates at €0.34 per km, significantly lower than the ICEV's €0.40 per km. This cost efficiency can be key for the logistics operations of BPost, leading to substantial savings over time.

Comparing these results with the Coffee Island use case, where the TCO for the URBANIZED vehicle was €41,176.15 and for the ICEV €61,045.67, it becomes evident that the URBANIZED vehicle consistently offers economic advantages across different operational environments. In both cases, the electric vehicle's lower feeding, insurance, and maintenance costs contribute to a more favourable TCO, despite varying operational conditions and local cost factors.

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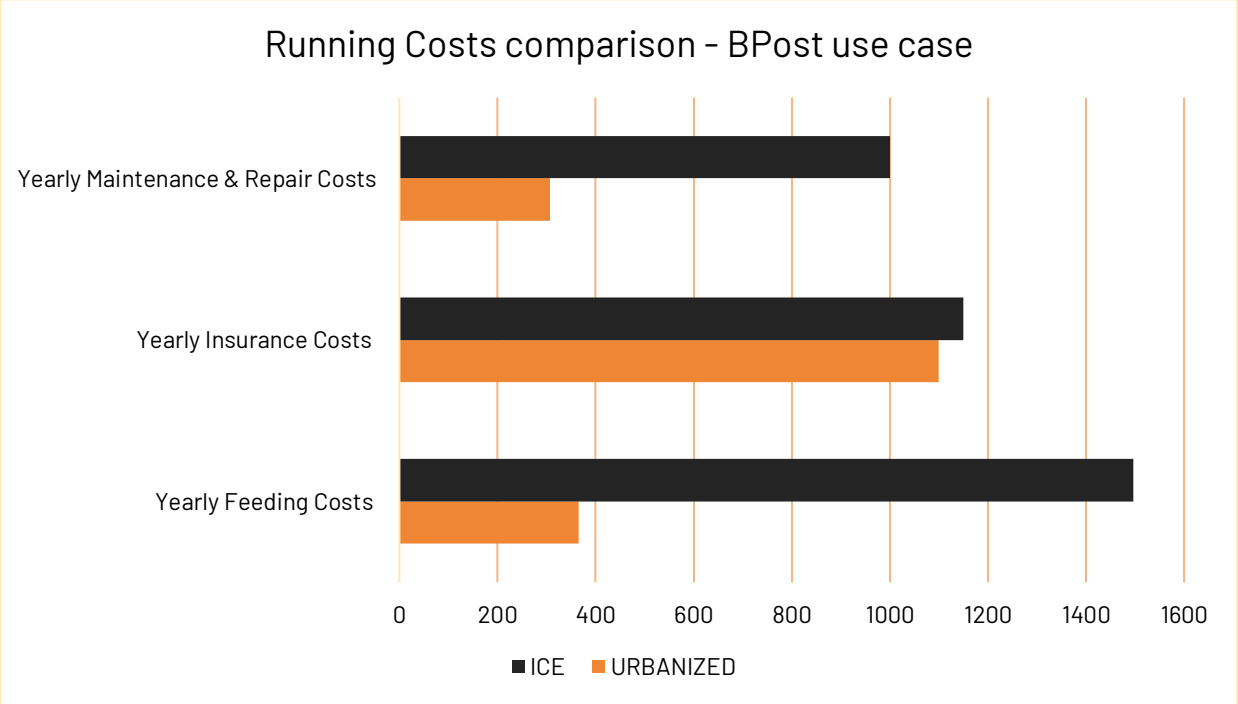

Figure 12: Running Costs comparison – BPost use case

3.3.3 Fleet level: Coffee Island use case results

Leveraging the TCO formula aforementioned, we scale up the cost analysis at the fleet level, with different assumptions on fleet size and utilization, stemming from simulations results explained in D7.1.

Assuming a period of ownership of 8 years for each vehicle, the TCO for the URBANIZED fleet amounts to €1,153,977.50, whereas the ICEV fleet's TCO reaches €1,313,596.63. This substantial difference of approximately €159,619.13 favours the cost-efficiency of the URBANIZED fleet, driven by several key factors explained below.

The annual feeding costs for the URBANIZED fleet are significantly lower, totalling €74,971.35 over the 8-year period. This is mostly due to lower cost of kilowatts compared to diesel fuel (that are also expected to rise over time but assumed constant in this analysis), which results in substantial savings on fuel expenses. In contrast, the ICE fleet incurs €312,099.56 in feeding costs, reflecting the higher price and consumption rate of diesel fuel. These lower feeding costs for the URBANIZED fleet are a strong argument for the shift towards more efficient electric propulsion.

Insurance costs also favour the URBANIZED fleet, with annual premiums totalling more than €210,600 over the 8-year period, compared to €211,200 for the ICEV fleet. Although the difference is not as pronounced, the marginally lower insurance costs for the EVs still contribute to the overall cost savings. This is partly due to the generally lower risk profile associated with electric vehicles, which benefits from a roughly 30% discount compared to their diesel counterparts.

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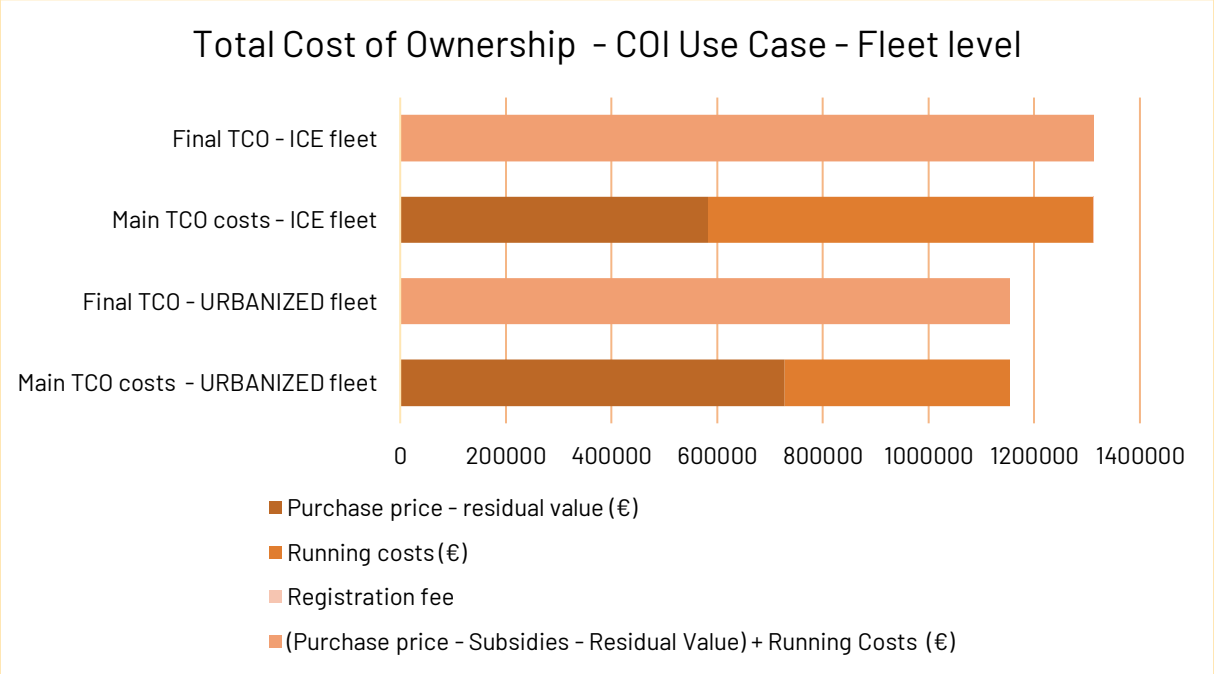

Figure 13: TCO Results - Coffee Island use case - Fleet level

Maintenance and repair costs further demonstrate the economic advantage of the URBANIZED fleet. The total maintenance and repair costs for the URBANIZED fleet amount to €118,620.22, significantly lower than the €164,180.02 incurred by the ICEV fleet. This reduction is largely due to the fewer moving parts in electric vehicles, which results in lower maintenance requirements and costs. The absence of components like oil and filters in EVs further contributes to these savings, making the URBANIZED vehicles more cost-effective to maintain over time.

The financial benefits of government subsidies play a major role in shifting the TCO in favour of the URBANIZED vehicles. The substantial subsidies received at the time of purchase, amounting to €8,000 for each vehicle, effectively lower the initial acquisition cost of the EVs. These incentives are critical in making electric vehicles financially competitive with traditional diesel vehicles, as they offset the higher upfront costs associated with EV technology until purchase prices become similar after e-LCV producers reach economies of scale.

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4. Conclusions

The analysis presented in this document provided an in-depth exploration of the economic and operational advantages of the URBANIZED e-LCV within urban logistics, focusing two distinct use cases. The results illsutrate the cost benefits of e-LCVs compared with traditional ICE through a comprehensive Total Cost of Ownership (TCO) analysis, complemented by insights from Porter's Five Forces model.

The TCO analysis reveals notable cost savings for e-LCVs in urban logistics. For Coffee Island, the TCO for the URBANIZED vehicle over an 8-year period is €41,176.15, significantly lower than the €61,045.67 for the ICE vehicle. This €20,000 difference stems first from high governmental subsidies, but also from lower operational costs such as feeding, insurance, and maintenance. Annual feeding costs for the URBANIZED vehicle are €1,016.60, compared to €2,271.67 for the ICEV, due to cheaper electricity costs compared to diesel. Insurance premiums also favour the electric vehicle, with annual costs of €900 versus €1,200 for the diesel counterpart. Additionally, maintenance and repair costs are lower for the electric vehicle, amounting to €307 annually compared to €1,195.01 for the ICE vehicle.

At the fleet level within the Coffee Island use case, the URBANIZED fleet, comprising 26 vehicles, demonstrates even greater economic benefits. Over eight years, the fleet's TCO totals €1,153,977.50, compared to €1,313,596.63 for the ICE vehicle fleet. This €159,619.13 difference highlights the cost-efficiency of the electric fleet, which is enhanced by higher utilization rates and superior load factors. The URBANIZED fleet's load factor of 94.2% reduces empty trips, thereby lowering operational costs. In contrast, the ICE vehicle fleet's load factor of 67.4% leads to more frequent trips and increased fuel consumption.

These findings align with existing research emphasizing the cost benefits of electric vehicles. Lebeau et al. (2019) and Bubeck et al. (2016) found that smaller electric vans, benefiting from less expensive batteries and government subsidies, are competitive with conventional vehicles. Morrison et al. (2018) extended this analysis to light-duty vehicle segments, showing cost benefits across different driving ranges and sizes .

Porter's Five Forces analysis further clarifies the competitive landscape for e-LCVs. The high capital requirements and advanced technological expertise needed create significant barriers for new entrants. Established manufacturers leverage economies of scale, brand loyalty, and robust supply chains to maintain their market position. Suppliers hold substantial bargaining power due to the specialized components required for e-LCVs, while large fleet operators and logistics companies exert significant bargaining power as key customers.

The threat of substitutes, including traditional ICE vehicles and alternative-fuelled vehicles, remains, but growing sustainability and regulatory pressures favour e-LCV adoption. Emerging non-vehicular alternatives like cargo bikes and electric scooters offer cost-effective and environmentally friendly solutions for last-mile deliveries in urban areas.

Rivalry among existing e-LCV competitors is intense, with major players like Tesla, Rivian, and Ford, alongside startups, contributing to a highly competitive market. Manufacturers must prioritize continuous innovation, cost efficiency, and brand loyalty to secure a competitive edge. Strategic partnerships, market segmentation, and economies of scale are crucial for sustained profitability in the e-LCV market.

In conclusion, this evaluation emphasises the economic viability and strategic benefits of adopting e-LCVs in urban logistics. The TCO analysis shows substantial cost savings over ICEVs, driven by high subsidies,

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lower operational costs and favourable insurance premiums. Porter's Five Forces analysis underscores the importance of innovation, cost efficiency, and strategic partnerships in the competitive e-LCV market which is at the core of the URBANIZED project. These suggest that the URBANIZED vehicle offers a compelling case for transitioning to sustainable and cost-effective urban logistics solutions, aligning with broader trends and research findings in the industry.

Acronyms

Acronym	Meaning
BEV	Battery Electric Vehicle
HoReCa	Hotel/Restaurant/Catering
ICE	Internal Combustion Engine
KPI	Key Performance Indicator
LCV	Light Commercial Vehicle
SotA	State of the Art
SUMP	Sustainable Urban Mobility Plan
SULP	Sustainable Urban Logistics Plan
TRL	Technology Readiness Level
TCO	Total Cost of Ownership
UFT	Urban Freight Transport
URBANIZED	modUlaR and flexible solutions for urBAN-sIzed Zero-Emissions last-mile Delivery and services vehicles
ViL	Vehicle-in-the-Loop
WP	Work Package
ZE(V)	Zero Emission (Vehicle)

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