eit InnoEnergy

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Finding the Right Mix: The Hidden Costs, Complexities, and Benefits of Mixed Electric Fleets in Last-Mile-Logistics

Contents

Introduction

"A data-driven study based on real-world inputs and quantitative modelling showed that efficiency gains plus the proper planning of micro-fulfilment centres for e-cargo bike delivery are enough to offset the hidden costs and provide a cost-competitive, sustainable solution today."

Jennifer Dungs, Global Head of Mobility at EIT InnoEnergy

1. Executive Summary

Logistics operators face a daunting task: decarbonising their last-mile delivery operation while grappling with price competition, shrinking margins, regulatory complexities, limited urban space and unpredictable demand surges. With e-commerce driving parcel volume growth by 8–14% in the EU each year*, pressure mounts on the last mile to become more flexible and cost-efficient. And with cities all over the world set to impose more restrictions or outright bans on large and polluting vehicles, the need to reduce congestion and emissions becomes more pressing. In response, industry players are piloting e-cargo bikes as an efficient, low-carbon and cost-effective solution to the last-mile delivery challenges. But replacing delivery fleets of internal combustion engine (ICE) vans with a mixed fleet of e-vans and e-cargo bikes is not straightforward. There are hidden costs and complexities that impact the bottom line, starting with upstream operations outside the urban delivery areas. This creates uncertainty about the overall efficiency and cost-effectiveness of implementing mixed fleet models on a larger scale.

Addressing these concerns can help paint a clearer picture of the untapped benefits of widespread mixed e-van and e-cargo bike adoption. To this end, EIT InnoEnergy worked together with a leading strategy consulting firm and several courier, express, and package delivery (CEP) players on an in-depth analysis to unpack the hidden costs and complexities, evaluating how mixed fleets can achieve meaningful cost and emission savings. This analysis therefore presents a valuable decision aid for executive-level decision-makers in the logistics, CEP, and related sectors in Europe and beyond to the last-mile delivery challenges.

Using real-world data and quantitative modelling, the study compares different types of fleets operating in three different city archetypes and with two scenarios for infrastructure set-up and operations: (1) a pure ICE van fleet; (2) a 100% electric van (e-van) fleet and (3) mixed fleets with varying proportions of e-cargo bikes and e-vans. The results and conclusions throughout the study are based on inputs from the strategy consulting firm, published sources, expert interviews, and the joint results of the modelling.**

*Based on forecasts by McKinsey, Euromonitor, IMF, and Transport Intelligence.
**Numbers are rounded.

Switching to mixed electric delivery fleets can save logistics providers significant costs

up to **8 Cents** per parcel or 5,3% can be saved today (2023)

up to **28 Cents** per parcel or 17% can be saved by 2030

only ≤ **2.8%** of total costs represent MFCs* for mixed delivery fleets (page 15)

60% lower leasing costs for e-cargo bikes today (2023) than for e-vans (page 17)

4% to 16% additional personnel costs from utilising mixed fleets, incl. up to 79% extra cost for upstream sorting and intralogistics (page 15)

e-Cargo Bikes	Electric Vans	2023 Large, sprawled out city	2023 Densely populated city	2023 Medium-sized city	2030 Large, sprawled out city	2030 Densely populated city	2030 Medium-sized city
0%	100%	1.44 €	1.41 € per parcel	1.46 €	1.62 €	1.59 € per parcel	1.64 €
80%	20% (optimised case)	1.41 € 1.8 %	1.34 € per parcel 4.5 % savings	1.38 € 5.3 %	1.40 € 14.0 %	1.33 € per parcel 16.0 % savings	1.36 € 17.0 %
60%	40% (baseline case)	1.42 € 1.3 %	1.36 € per parcel 3.4 % savings	1.40 € 4.0 %	1.45 € 10.0 %	1.39 € per parcel 12.0 % savings	1.43 € 13.0 %
30%	70% (conservative case)	1.43 € 0.7 %	1.38 € per parcel 1.7 % savings	1.43 € 2.0 %	1.54 € 5.0 %	1.49 € per parcel 6.0 % savings	1.54 € 6.0 %

Savings potential for a large logistics player delivering 2B parcels a year

~€156M p.a. today (2023) and **~€554M** p.a. by 2030 (80/20 fleet mix)

~€95M p.a. today (2023) and **~€390M** p.a. by 2030 (60/40 fleet mix)

Illustration Doreen Borsutzki

Key Results at a Glance

Today (2023), a company delivering 2 billion parcels a year can save €95–156 million annually by switching to a mixed e-van / e-cargo bike fleet.

The total **cost per parcel** for a 60% e-cargo bike / 40% e-van fleet in a densely populated city was **€1.36**, compared to **€1.41** for a 100% e-van fleet.

The €0.05 difference per parcel would yield savings of **€95 million per year today**, equivalent to **3% of the cost of an e-van fleet.** Savings increase to **€390 million** by 2030.

A more optimal mixed fleet with 80% e-cargo bikes and 20% e-vans yields even further annual savings— **€156 million today and €554 million by 2030.**

Reduced CAPEX/OPEX for vehicle and charging infrastructure offset the new costs incurred by mixed fleets — while maintaining delivery productivity.

CAPEX/OPEX of new Micro Fulfilment Centres and higher personnel costs for intralogistics, sorting, and delivery result in a cost increase up to 8% (€0.05/parcel) for a 60%/40% mixed fleet, compared to a 100% e-van fleet.

However, these new costs are offset by an **12% cost decrease** from vehicle and charging infrastructure savings. Lower leasing costs and reduced charging infrastructure needs for e-cargo bikes reduce costs by **€0.16/parcel.**

E-cargo bikes offset their 40% lower parcel capacity with **40% efficiency gains** from less time spent walking and parking, as well as shorter line-haul distances for each round trip from the Micro Fulfillment Centre.

Win-win for cities: By promoting the use of mixed fleets in city centres, cities benefit from less congestion, greener urban logistics, and more.

With 15–58% fewer kilometres driven by vans per day, cities can **reduce CO_2 emissions by 62–81%** compared to 100% combustion-engine van fleets.

The total number of delivery vans in the 100 largest EU cities can be reduced up to 120,000, saving 98–122 million kg of CO_2 per year and **cutting last-mile emissions 73–80%.**

Reduced charging for e-cargo bikes compared to e-vans could **save €24–32 million in electricity costs** across the entire European e-delivery fleet.

2. Economic & Environmental Tailwinds for Urban Logistics

The **recent wave of rapid growth in the EU parcel market** has brought numerous challenges to the surface: shrinking margins, decarbonisation targets, and regulatory fragmentation. To navigate them, industry players, start-ups, and VCs have made the last mile a central focus, pouring $6.5 billion in Europe alone into the space since 2019 (Pitchbook). This is setting the stage for a transformative shift away from the polluting legacy last-mile operations, propelling the industry toward improved profitability, reduced environmental footprint, and exceptional customer service.

Parcel demand is only going to grow. With just 20 parcels per capita, the EU has yet to catch up with the US, which boasts a whopping 45 parcels per capita. Forecasts by McKinsey, Euromonitor, IMF, and Transport Intelligence show parcel volumes in the EU doubling from 16.5 billion in 2020 to 34 billion in 2030, while the global market is expected to grow to $1 trillion by 2028. Moreover, fuelled by the boom in e-commerce, the B2C market share is projected to further expand to 80%, putting more pressure on last-mile operations because of typical lower drop rates and more stops for B2C parcel delivery. However, the **rise of B2C parcels opens the door to more suitable form factors**, such as e-cargo bikes.

Without intervention, projections from McKinsey indicate that this surge in parcel deliveries could **add up to 40,000 vehicles to the existing fleet of over 230,000** on European city streets by 2030, further straining urban infrastructure and the environment. Globally, last-mile-induced congestion could raise average commute time by 21% in 2030, emitting an extra 6 million tonnes of CO_2 (WEF). In addition, with 200,000 traffic jams per year across 123 major European cities today, congestion-associated costs could reach €223 billion by 2025 (INRIX), equivalent to 1.5% of EU's GDP. Not surprisingly, despite being the shortest leg, the **last-mile accounts for 40-50% of the total parcel delivery costs** as well as **50% of the total CO_2 emissions** (Clean Mobility Collective).

What are cities doing in response? The development and deployment of Low Emission Zone (LEZ) laws primarily focus on phasing out older petrol or diesel vehicles, with over 150 cities worldwide having initiated diesel/traffic bans. For instance, Amsterdam and other 13 Dutch cities have committed to fully electric delivery by 2025, while Stockholm, Madrid, and Oslo, among other major European cities, are taking steps to curb inner-city car and larger vehicle numbers through tolls, congestion fees, and by incentivising the use of zero-emission delivery vans under 3.5 tonnes. Many cities are likely to expand these restrictions, allowing only LEVs into city centres. As a result of these kinds of initiatives, driven by regulations and changing customer demands, McKinsey predicts that **80% of all last-mile deliveries in Europe will be carbon-neutral by 2030.**

In the quest to decarbonise last-mile delivery, many logistics companies are plugging into fleet electrification as a key strategy. Amazon's commitment to make its delivery fleet fully electric by 2030 reflects an industry-wide trend. The transition to zero-emission last-mile delivery has started. Internal combustion engine (ICE) vans are being substituted for battery-electric vans. But replacing one van with another (albeit zero-emission) is missing out on the additional advantages that e-cargo bikes can offer. E-cargo bikes can improve road space utilisation, emissions, and safety. Additionally, e-cargo bikes provide resilience against fluctuations in fuel and electricity prices, as well as a flexible model to cope with sudden bursts in demand, as seen during the COVID-19 pandemic.

So why aren't more e-cargo bikes used for last-mile deliveries today?

Replacing an entire delivery fleet of ICE vans with a mixed fleet of e-vans and e-cargo bikes is not straightforward. There are hidden costs and complexities that raise concerns about the overall efficiency and cost-effectiveness of implementing such models on a larger scale. This study aims to uncover these and present a holistic comparison of the entire process.

34B

in parcel volumes by 2030

Up to 40,000

more delivery vehicles on city streets by 2030

21%

longer commute times due to traffic increase by 2030

3. Methodology & Calculations

This study delves into the hidden costs and complexities of last-mile parcel delivery, assessing the extent to which mixed fleets comprised of e-cargo bikes and electric vans can deliver cost and emission savings. By employing quantitative modelling and real-world data from various CEP players, the study conducts a comparative analysis of different delivery fleet compositions under various urban operating scenarios, with a particular focus on quantifying complex upstream costs.

Furthermore, in the context of last mile decarbonisation, the aim is to compare the cost of achieving this through fleet electrification using e-vans versus employing a mixed fleet of e-cargo bikes and e-vans. However, the benchmark case of ICE vans is still included for reference.

3.1. Unpacking the Complexities

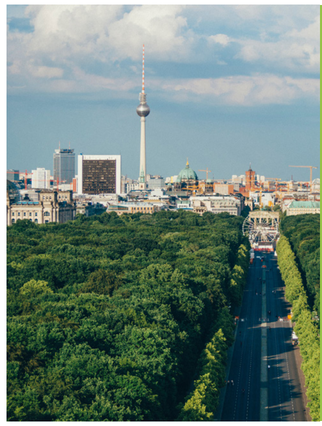
In conventional distribution models, parcels are **distributed from an intralogistics centre** via outer-city depots to the end customer, using ICE or battery electric delivery vans on the final leg. However, e-cargo bike deliveries, with their limited range and capacity, **require the use of additional micro fulfilment centres (MFCs)** that are located closer to the end customer, inside the delivery district. These hubs receive the pre-consolidated parcels from the delivery trucks and transfer them to the e-cargo bikes.

However, before the parcels are brought to the MFC, there are **upstream costs** that need to be considered, occurring at the intralogistics centre. The main intralogistics costs are related to personnel (pre-sorting, route planning, and inbound/outbound driving to the MFCs). The packages planned for e-cargo bike delivery must be sorted out, manually — requiring extra personnel costs, due to e-cargo bike limitations on both weight and size. The study provides a detailed breakdown of these costs and their impact on a logistics company's bottom line in the results section.

3.2. City Archetypes

The study utilised three city archetypes with specific urban parameters to model parcel demand and cost drivers related to population density. By understanding the city demographics, efficient distribution systems can be tailored to each city distinct and urban landscape.

The study's baseline case uses the **second city archetype** of a **densely populated city.** This relatively large but compact city archetype is best suited for initial deployment of mixed fleets.

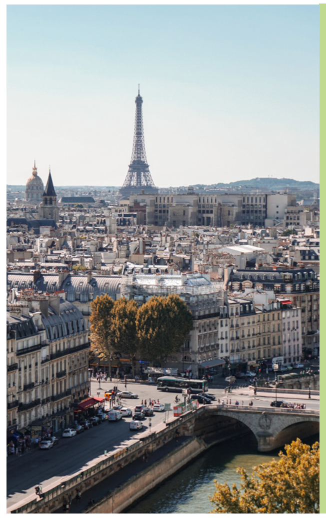


1. Large, sprawled-out city (with large geographical spread)

Examples: Berlin, Hamburg, London, Madrid, Rome

These major metropolises are home to millions of residents, encompassing vast urban areas of more than 600 km^2 with patches of high population density concentrated at the city centre. The sprawling layout, however, can lead to a more dispersed delivery and longer distances. The unique challenge lies in adopting optimal last-mile approaches to overcome the geographical spread and ensure timely and cost-effective deliveries.

Average yearly parcel volume of 170 million.



2. Densely populated city (with lower geographical spread)

Examples: Amsterdam, Athens, Barcelona, Budapest, Copenhagen, Lisbon, Lyon, Munich, Naples, Paris, Stockholm, Vienna, Warsaw

Home to between several hundred thousand and a few million residents, these cities are characterised by a more compact layout with higher population density, covering a moderate geographical area of around 350 km^2 compared to their larger counterparts. In these cities, efficient space utilisation, walkability, and well-connected infrastructure create a conducive environment for e-cargo bike delivery operations. However, challenges like traffic congestion and limited parking require meticulous route planning and optimisation to ensure seamless and timely last-mile deliveries.

Average yearly parcel volume of 110 million.

3. Medium-size city (with a blend of spread and density)

Examples: Antwerp, Bordeaux, Bratislava, Dublin, Frankfurt, Glasgow, Nantes, Palermo, Stuttgart

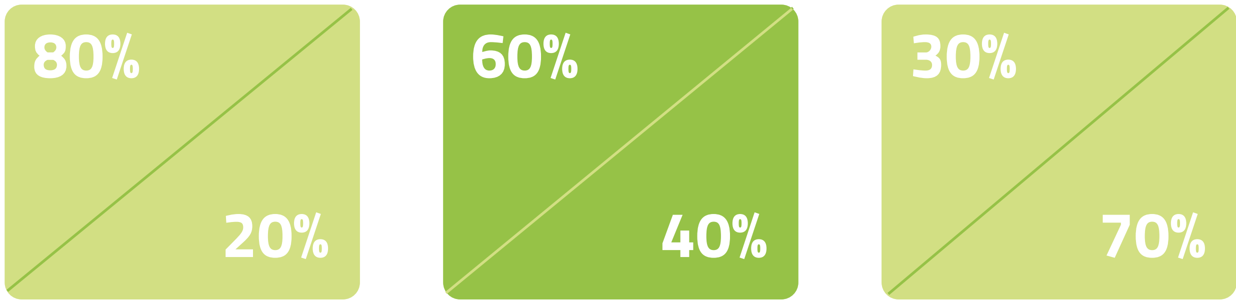
Balancing characteristics of both sprawled out and dense cities, these medium-sized cities exhibit smaller geographical areas of around 200-300 km^2 and lower population densities, accommodating a few hundred thousand to well over half a million residents. Their urban form offers a blend of urban spread and density, presenting both opportunities and challenges for last-mile logistics. However, they also offer a unique testing ground and ideal setting for finding scalable and adaptable distribution models.

Average yearly parcel volume of 46 million.

3.3. Mixed Fleet Composition — Three Different Scenarios

E-cargo bikes are well-suited for smaller and lighter parcels, especially for B2C deliveries, as they can efficiently navigate dense urban areas with high residential shares and traffic congestion. CEP players have indicated the potential for e-cargo bikes to cover 60% to 80% of B2C parcel volumes in high-density areas.

The study's baseline was therefore based on a mixed fleet with 60% share of e-cargo bikes and 40% e-vans. This composition allows e-cargo bikes to excel in their designated areas, serving B2C deliveries efficiently, while e-vans take on the rest of the deliveries in locations where e-cargo bikes are not the optimal choice. Two additional 'bookend' scenarios were calculated. These consist of 80%/20% e-cargo bikes/e-vans and 30%/70% e-cargo bikes/e-vans.



Optimised scenario *Baseline scenario* *Conservative scenario*

3.4. Cost Projection by 2030

The study also considers the evolving landscape of last-mile logistics by projecting mid-term cost scenarios for 2030, a pivotal year marking high B2C parcel projections, low and zero emission zones, fleet electrification targets, and a progress point in Europe's "Fit for 55" regulation. The study considered the impacts on key factors for both e-cargo bike and e-van fleets.

First, e-cargo bikes are assumed to achieve a 20% further reduction in leasing costs as start-up players reach mass-production efficiencies and optimise their Bill of Materials (BOM) by 2030. The projected improvement of biking infrastructure and repurposing of inner-city roads is reflected in shorter walking and parking times per stop. Lastly, the already established micro-fulfilment centres are expected to remove CAPEX costs.

A recent study suggests that the total cost of ownership (TCO) of e-vans is already comparable to that of ICE vans in Europe (T&E), especially when subsidies are taken into account, and the costs may continue to decrease until 2030. This is reflected in the report when it comes to OPEX. However, the purchase price of an e-van (leasing costs) is left unchanged until 2030, as market dynamics and prolonged bottlenecks in the e-van supply chain (with delivery times exceeding 18 months for some players) could keep prices high in the near-term. Nonetheless, depending on demand-supply, it is possible that e-van prices will be 20–25% lower than ICE vans by 2030. (BNEF)

In addition, new inner-city regulations for congestion and low/zero emission zones affect driving speed limits within delivery districts, reducing them from 10 km/h to 8.5 km/h, and result in increased fees for parking and circulation at €0.02 per parcel. However, capital expenses for charging infrastructure are excluded in this scenario as the infrastructure is expected to be in place by then.

3.5. Packing it All Together

In total, nearly 40 different scenarios were used for the competitive analysis.

Fleet Composition	City Archetypes	Micro Fulfilment Centre Setup	Cost Projections
1. 100% ICE van fleet 2. 100% electric van (e-van) fleet 3. Mixed fleets of cargo bikes & e-vans: a. 30% / 70% b. 60% / 40% c. 80% / 20%	1. Large & sprawled-out 2. Densely populated 3. Medium-size	1. Establishing & operating **new** MFCs 2. Leveraging **existing** MFCs	1. Baseline costs today (2023) 2. 2030 cost projection

City Archetype & Parcel Demand	Sorting Costs at MFCs (Personnel)	Intralogistics Costs (Personnel)	MFC Costs (CAPEX, OPEX)	Vehicle & Infrastructure Costs (CAPEX, OPEX)	Last-Mile Delivery Rider Costs (Personnel)
▪ Size area (km²) ▪ Population (#) ▪ Population density (ppl/km²) ▪ Parcel volume (#) ▪ Share of area covered by vehicle (%) ▪ Share of parcel volume covered by vehicle (%)	▪ Annual wage per FTE (€) ▪ Number of e-cargo bikes (#) ▪ Absence factor ▪ Delivery days per year (#) ▪ Sorting time per district (hrs) ▪ Labour cost per hour (€)	▪ Parcel loading capacity per truck (#) ▪ Preparation time (hrs) ▪ Pre-sorting time (hrs) ▪ Radius of delivery district (km) ▪ Driving speed to and in district (km/h)	▪ Size area (m²) ▪ Initial CA-PEX (€) ▪ Rent per sqm (€/m²) ▪ Main-tenance costs share (%) ▪ Admin costs share (%) ▪ Other OPEX costs (%)	▪ Vehicle leasing costs (€) ▪ Other vehicle costs (€) ▪ Equipment costs (€) ▪ Electricity consumption (kWh/km) ▪ Electricity price (€/kWh)	▪ Vehicle size (m²) ▪ Radius of delivery zone (km) ▪ Drop Factor (#) ▪ Retour Factor (#) ▪ Number of delivery rounds necessary (#) ▪ Packages delivered per FTE per day (#)

Table inputs: Strategy consulting firm, published sources, and expert interviews

4. Results

For a logistics company, the **price per parcel** is a critical measure of cost efficiency, especially when choosing the right decarbonisation pathway for last-mile delivery fleets. Across nearly 40 fleet scenarios, the study demonstrates that integrating e-cargo bikes into e-van fleets has the potential to deliver tangible cost savings.

For the study's baseline case consisting of a mixed fleet with 60% e-cargo bikes and 40% e-vans, operating in a densely populated city (hereafter referred to as: baseline mixed fleet case), the total cost was **€1.36/parcel.** Compared to the cost of **€1.41/parcel** for a 100% e-van fleet operating in the same city, this results in savings of **€0.05/parcel.**

To put this into perspective, **for a logistics company delivering 2 billion parcels a year, these savings translate to nearly €95 million per year — today, in 2023**!

These baseline case savings come from the **reduced vehicle and charging infrastructure CAPEX/OPEX** of e-cargo bike delivery operations, which effectively **offset their higher personnel costs of +10% and newly added MFC-related CAPEX/OPEX representing 1.7% of total costs.** But how much are the savings? And under what conditions are they most significant? Let's sort it out!

4.1. Sorting out the Costs

Personnel costs make up the bulk of mixed fleet last mile delivery costs, **ranging from roughly 70 to 80%.** Increased **sorting time is the primary driver.** But there is also an increase in final delivery rounds, as well as new additional intralogistics operations to feed the MFCs, that must be considered. The remaining 20–30% of expenses come from the CAPEX/OPEX of vehicles and charging infrastructure, and from new additional MFC-related costs.

To break down the cost impact of integrating e-cargo bikes into e-van delivery fleets, the study examines, 'bucket by bucket', the new added costs and the additional increase in existing costs (both CAPEX/OPEX and personnel), and then looks at how these are offset by the gains in CAPEX/OPEX. To put this back into perspective, the study also looks at the impact of each cost category on the bottom line using the example of the 2 billion parcel/year logistics company mentioned above.

Figure 1 on the next page shows the absolute costs (€) per parcel for each of the steps along the last-mile delivery process. The data used was for the baseline mixed fleet case.

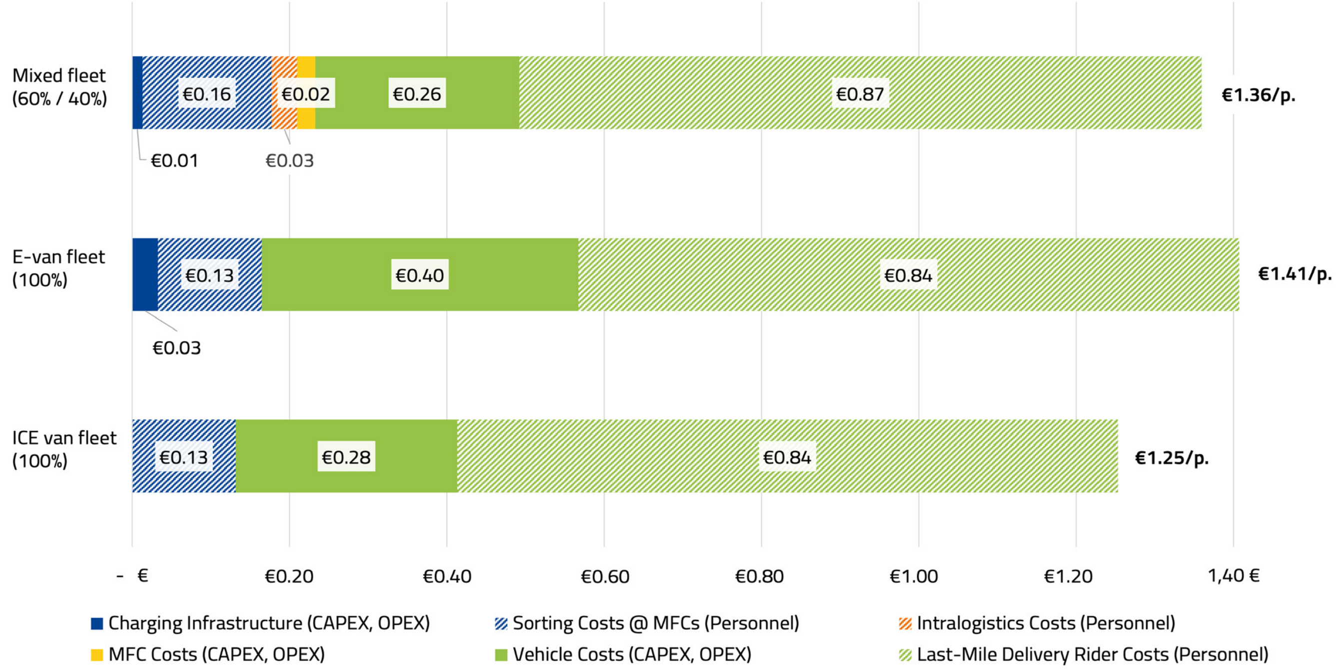


Figure 1. Breakdown (€/parcel) of CAPEX, OPEX and personnel costs along the last-mile delivery process

Focusing only on the upstream personnel costs related to sorting and intralogistics, the increase compared to a pure e-van fleet is +49%, underlining the additional time needed. Overall, the personnel costs increase 10%, which then includes the last-mile delivery rider costs. The range across all scenarios is +24–79% for upstream personnel costs and +4–16% for total personnel costs.

For the baseline case of 60% e-cargo bikes and 40% e-vans, the personnel costs represent 78% of the total. Personnel costs were 69% of the total for the pure e-van fleet (Figure 2).

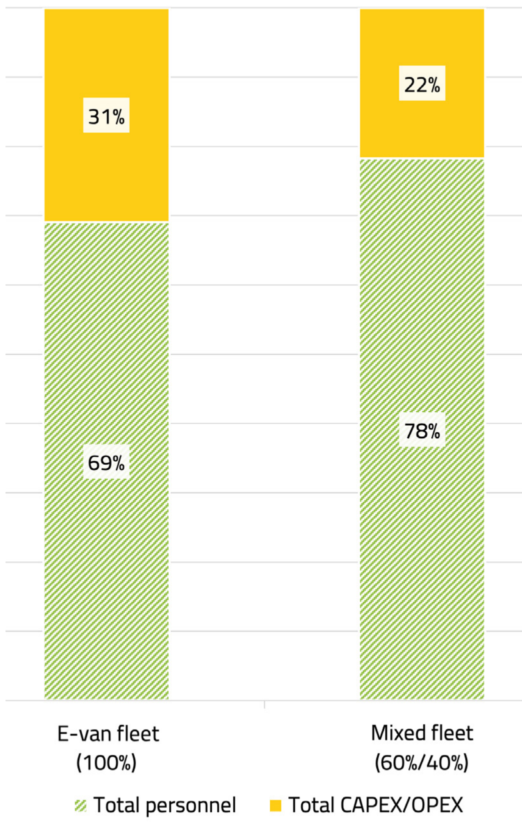


Figure 2. Share (%) of CAPEX, OPEX and personnel costs for 100% e-van and 60%/40% e-cargo bike/e-van mixed fleets

MFCs: Options for CAPEX-light Setup and Efficiency Gains

Setting up new MFCs incurs new capital and operational costs. These range from €7M/year/city in large, sprawled-out cities with mixed fleets of 80% e-cargo bikes (where over 200 hubs are needed) to €0.6M/year/city in medium-size cities with 30% e-cargo bikes (requiring fewer than 30 hubs). For the baseline mixed fleet case, **MFC-related costs add €0.02/parcel** to the total costs of an e-van fleet operation, which translates into **€45M/year** for a logistics company delivering 2 billion parcels per year. For the baseline case, it represents 1.7% of the total costs and, in the worst case, up to 2.8% of the total cost.

The primary lever to **optimise the MFC-associated costs** is to **leverage existing under-utilised urban spaces** which are or have been converted into urban hubs. An example of this is APCOA's urban hubs. When leveraging existing space, the MFC costs are reduced to an annual registration fee and the rental of parking spaces — resulting in savings of 42–56%. The previous MFC costs would thus be reduced from €7M to €3M/year/city in the first case, and from €0.6M to €0.3M/year/city in in the second case. Looking again at the baseline mixed fleet case, **the logistics company delivering 2 billion parcels per year would save €20 million annually.**

While MFC costs make up a smaller fraction of the total expenses (up to 2.8% of total costs), their setup significantly impacts the entire distribution system, especially when defining the MFC's service area based on factors like population density and parcel demand. The study shows that as the service area radius decreases, final delivery costs (including personnel, sorting, and vehicle costs) go down due to reduced mileage and fewer required bike riders. However, this necessitates more hubs to cover the entire delivery district, increasing MFC costs, especially for radii under 1 kilometre. Intralogistics costs also rise, but not significantly unless the number of hubs increases dramatically (for radii below 1 km). Therefore, an optimal service area radius is crucial to minimise total costs, and this varies by city archetype: about 1.3 km for large, sprawled-out cities, close to 1.0 km for densely populated cities, and 1.1 km for medium-size cities. The findings reveal that the costs per parcel for an e-cargo bike distribution system are lowest in densely populated cities.

Intralogistics Operations: A Missing Piece with Unseen Complexities and Cost

New additional personnel costs originate from the upstream intralogistics operations. These include pre-sorting for e-cargo bike delivery, as well as route planning and the associated costs for inbound-outbound operations to feed the MFCs via trucks. When using vans or e-vans to feed the MFCs as opposed to larger trucks, personnel costs quadruple. This is due to their lower capacity: more than 700 vans are needed to do the job that 180 trucks can do in larger cities, increasing the number of kilometres travelled in the district fourfold.

Altogether, these personnel costs span from €0.8M/year/city in medium-size cities with mixed fleets of 30% e-cargo bikes to €10M/year/city in large, sprawled out cities with 80% e-cargo bikes. The stark contrast between these figures underlines the significant influence of both city archetype and fleet composition, with the impact of the MFC distribution network on operations playing a key role as explained earlier.

For the baseline mixed fleet case, **intralogistics costs add €0.03/parcel** to the total costs of an e-van fleet operation, which translates into **€66M/year** for the large logistics company delivering 2 billion parcels per year. The new added costs so far amount to €111M/year.

Sorting at the MFC: Increase of Personnel Costs

Moving to the next 'bucket', the focus shifts to the MFC, where personnel costs increase due to the additional fine sorting required for the e-cargo bikes. This sorting process demands roughly 33% more time, from 1.5h to 2h per person per district, for parcels designated for e-cargo bike delivery.

In total, these personnel costs can range from €0.6M/year/city in medium-size cities with mixed fleets of 30% e-cargo bikes, up to €7M/year/city in large, sprawled out cities with 80% e-cargo bikes. Fleet composition has a significant effect here as well. Sorting costs increase by 13% for a mixed fleet with 30% e-bikes, 26% for a 60% e-bike fleet, and 34% for an 80% e-bike fleet, as compared to a traditional van-based scenario. For the baseline mixed fleet case, increased sorting costs add €0.03/parcel to the total costs of an e-van fleet operation, which translates into **€64M/year** for the logistics company delivering 2 billion parcels per year. Together with the new added costs, this 'bucket' brings the tally up to €175M/year.

Last-Mile Delivery Operations: Examining Every Incremental Change

Finally, the increase in personnel costs is also influenced by the final delivery to the end customer. On average, an e-cargo bike rider completes an individual round about 40% faster than a van or e-van driver. This includes 20% less time spent walking and parking per stop and shorter line-haul distances from the MFC compared to an outer-city depot. As a result, a bike rider can manage up to 2.6 delivery rounds per day, whereas van drivers handle 1.5 rounds. Despite e-cargo bikes having a lower parcel capacity, daily productivity remains comparable. For the baseline mixed fleet case, **last-mile rider delivery costs add €0.03/parcel** to the total costs of an e-van fleet operation, which translates into €55 million annual cost for the large logistics company.

Vehicle Costs: Including the Impact on CO_2 and Energy Consumption

The leasing and the electricity costs for e-cargo bikes are significantly lower than those for e-vans and ICE vans. E-cargo bike leasing today (2023) is **roughly 40% cheaper than leasing of ICE vans and 60% cheaper than leasing of e-vans**. The picture is similar when comparing electricity consumption costs per kilometre. Total electricity costs for e-cargo bikes are only 11% of the electricity costs for e-vans and 4,5%, of the fuel costs for ICE vans. Depending on the mixed fleet composition, the exact savings on total vehicle CAPEX/OPEX will vary, with 18% savings on vehicle costs for fleets composed of 30% e-cargo bikes and up to 48% savings for fleets composed of 80% e-cargo bikes.

*For the baseline mixed fleet case, **reduced vehicle expenses save €0.14/parcel** for the total costs of an e-van fleet operation, while **reduced charging infrastructure expenses save an extra €0.02/parcel.** These **cost savings amount to €325M/year** for a logistics company delivering 2 billion parcels per year, effectively **offsetting the €230M/year additional costs** accumulated so far. This achieves the* **€95M/year total savings** *mentioned earlier in this section, despite the significant costs and complexities of integrating e-cargo bikes into e-van fleet operations.*

4.2. Hitting the Bottom Line

With a deeper insight into the key cost drivers and cost savers for each facet of the last-mile delivery process, let's paint the complete picture of how integrating e-cargo bikes into a 100% e-van fleet impacts a logistics company's bottom line — see figure 3, based on the baseline mixed fleet case.

Hitting the Bottom Line: How will integrating e-cargo bikes impact my cost structure?

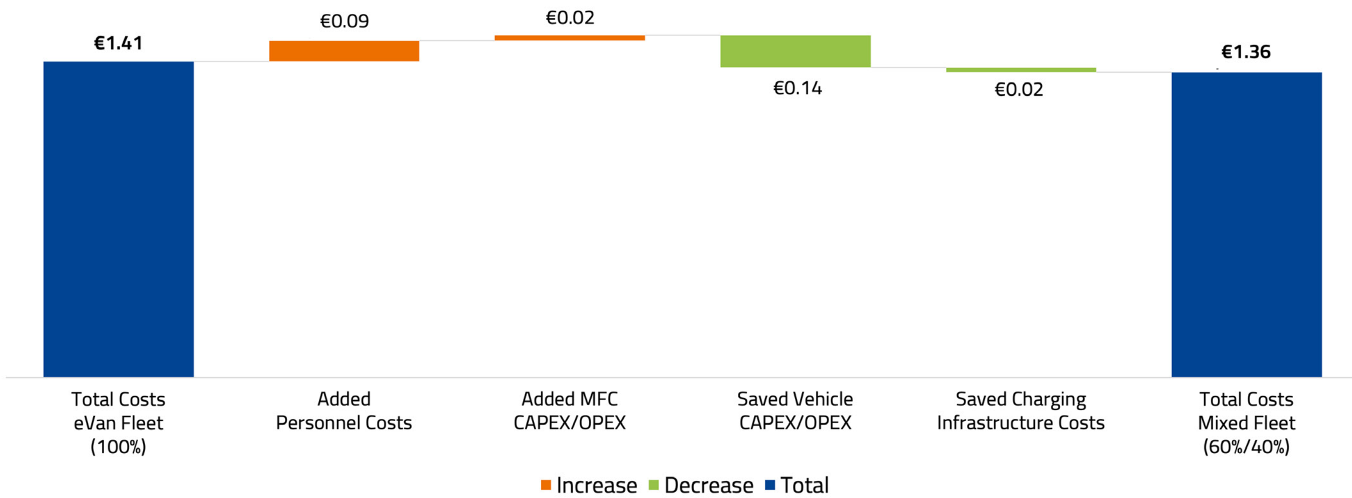


Figure 3. Waterfall chart showing additional costs due to personnel and MFC (CAPEX, OPEX) and savings of costs due to vehicle and charging infrastructure (CAPEX, OPEX) costs.

4.3. Decarbonisation Pathways for Last-Mile Delivery Fleets: Unlocking Cost Savings Today

The study shows that **the most substantial savings today, ~5%, are realised when a mixed fleet consists mainly of e-bikes** — e.g. 80%. Conversely, if the fleet includes fewer e-bikes (e.g. 30%), the savings drop to 1–2%. Hence, the general principle for unlocking cost savings — via e-cargo bikes — is clear.

Similarly, cost savings vary depending on the city archetype. **The highest savings are observed in the medium-sized city,** while the lowest savings are observed in the large, sprawled out city. However, the savings (%) are just one aspect. **Just as important — or arguably more — are the absolute costs.** While the highest savings (5%) occur in the medium-size city with 80% e-cargo bikes, the lowest costs (€/parcel) occur in the densely populated city (e.g., €1.34/parcel).

The reason is partly due to the operational costs of the e-vans, where the highest absolute costs are in medium-size cities (e.g., €1.46/parcel). Yet mixed fleet operations in large, sprawled-out cities face the highest costs (€1.41-1.43/parcel) and lowest savings (0.7%-1.8%).

In addition, **the optimal fleet composition may vary city-to-city** and even from district-to-district. Based on the results, the higher the density of B2C parcels, the more efficient it is to use a higher proportion of e-cargo bikes.

The **cost savings potential of mixed fleets is ~5% today (2023) and 17% in 2030.** However, the true magnitude of these savings becomes apparent when calculated for a logistics player delivering 2 billion parcels per year. Implementing mixed fleets today (2023) could result in **savings of €95M/year for the baseline case**, and **€156M/year for the optimised case** with an 80/20 split of e-cargo bikes vs. e-vans. By 2030, these **overall cost savings could amount to €390M/year for the baseline case and €554M/year for the optimised case.** These numbers should be sufficient to start the discussion on how and when to evaluate mixed fleets on a larger scale.

Moving Beyond Pilots: Unleashing True Cost-Efficiency

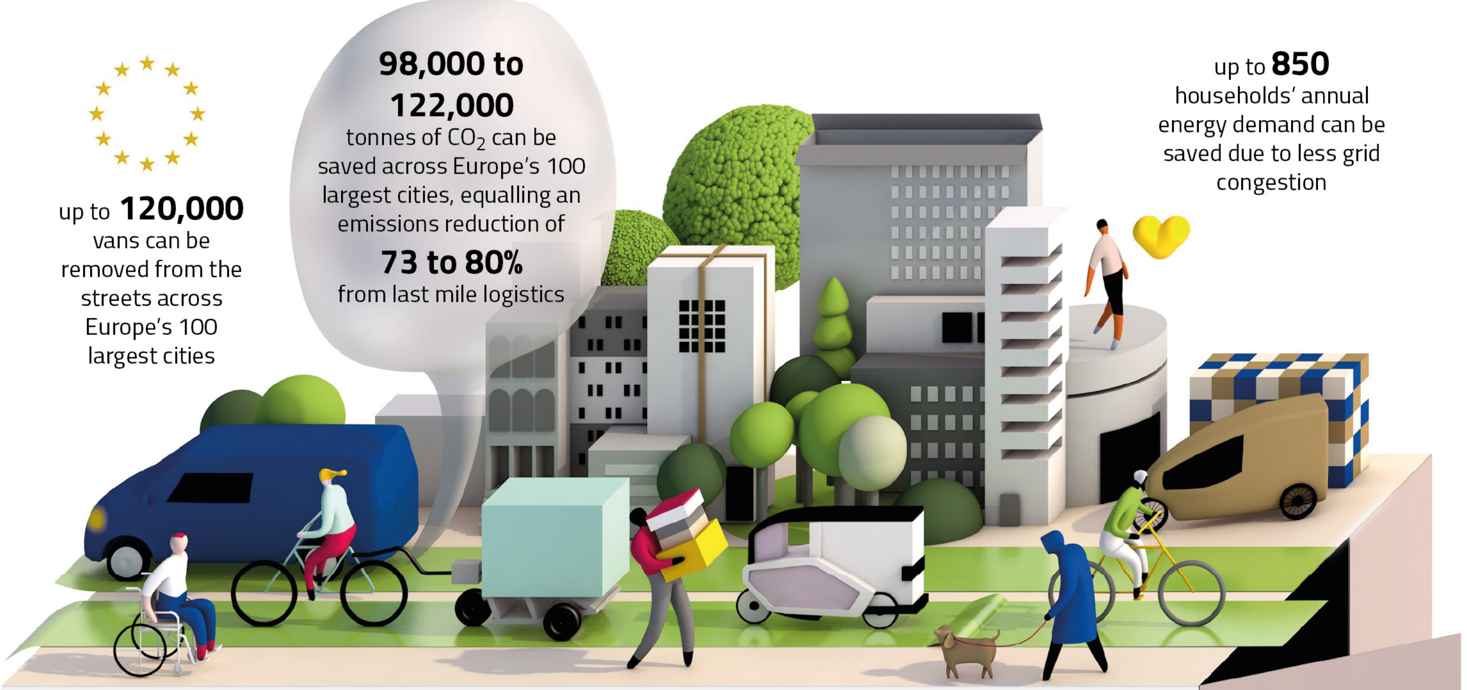
Pilot projects with only a few dozen e-cargo bikes will not deliver the promised cost savings for logistics operators. It is only by maximising the synergies between parcel demand density, hub distribution, and driver productivity with large(r)-scale deployments that greater cost efficiencies can be unlocked.

4.4. Meaningful Savings for Cities

The study revealed cost savings and efficiencies achieved by incorporating e-cargo bikes into last-mile deliveries. Beyond economic advantages for logistics operators, cities also stand to benefit from reduced congestion, lower emissions, increased safety, and enhanced urban space efficiency. From the city perspective, these spillover benefits uncover a win-win scenario of optimising last-mile delivery operations, for logistics operators and cities alike.

Cities are at a crossroads, holding the key to unlock even further potential for decarbonisation in the last mile. With an increasing number of low and zero-emission zones set to take effect by 2030, e-vans are primed to take over the streets. But simply replacing ICE vans with e-vans won't solve congestion; it will most certainly worsen it. Estimations from McKinsey suggest that without effective intervention, by 2030 last-mile delivery could result in a 21% increase in commuting time and 6Mt of additional CO_2 emissions. Cities have the chance to act swiftly now by extending their inner-city bans in favour of e-cargo bikes, tackling both congestion and emissions head-on. The industry is watching, ready to respond to the level of regulatory ambition.

How mixed electric delivery fleets can improve people's lives in the city



	Large, sprawled out city	Densely populated city	Medium-sized city
Less Congestion	15% - 38%	20% - 52% fewer km driven by vans per day	22% - 58%
Less Emissions Compared to 100% ICE van operations	62% - 78%	62% - 79% less CO_2 emissions from urban logistics	63% - 81%
Space Efficiency	980 - 2600 Vans removed from the streets	620 - 1650 Vans removed from the streets	270 - 700 Vans removed from the streets
Less Grid Congestion Compared to 100% e-van operations	1.2 – 3.2 GWh saved per city through less grid congestion	0.7 – 1.8 GWh saved per city through less grid congestion	0.4 – 1.0 GWh saved per city through less grid congestion

14–59% fewer kilometres driven by vans per day — reducing congestion

62–81% less CO_2 emission than 100% ICE van fleets

620–2,600 vans removed, per city, from the road

Illustration Doreen Borsutzki

5. The Way Forward — Pedalling Towards Sustainable Last Mile Logistics

The study shows that, despite additional costs and complexities, integrating e-cargo bikes into last-mile delivery offers not only significant cost savings, but also meaningful spillover benefits for society and the environment in diverse urban settings. Now, what are the next steps toward decarbonising last-mile delivery with mixed fleets of e-cargo bikes and e-vans?

Let's start with two of the key takeaways:

1. **Inconsistent and divergent regulatory frameworks** across cities are preventing logistics operators from embracing large-scale deployment, causing uncertainty and forfeited efficiency gains due to patchwork operations. Therefore, **collaborating with policymakers** at various municipal and government levels is seen as the next critical step towards action.
2. A similar need to **further collaborate and build a partner ecosystem** around last-mile logistics is emphasised, not only to facilitate knowledge exchange but also to enable orchestration and **resource optimisation.**

Drawing from both the study's findings and industry feedback, three crucial considerations were identified:

5.1. The Winning Strategy: Set Up and Collaborate

Establishing a sustainable last-mile logistics ecosystem is clearly no easy task. However, the set-up of shared MFCs can serve as a catalyst for multi-stakeholder partnerships, constituting a **'Minimum Viable Partner Ecosystem'.** The process involves pinpointing suitable hub locations, engaging with potential partners, and defining effective models for cooperation. Today, industry players are already actively pursuing diverse avenues to protect revenue-at-risk and leverage mutually beneficial commercial models.

Hereby, the importance of collaboration with municipal authorities is continually emphasised. The objectives of the city and logistics providers must be compatible. An increase in e-cargo bikes frees up city space and reduces the number of accidents which result from second-lane van parking in busy urban areas, as well as harm to cyclists from large turning vehicles in tight urban environments. Lower emissions and electricity use also have a positive impact for municipalities, not least because of the positive image that sustainable transport solutions bring.

Collaboration with municipalities may be required for allowing facilitated parking and driving of e-cargo bikes on footpaths. Local property owners will benefit from a better city climate, reduced noise and safer streets.

Similarly, cooperation models with emerging players can be established to optimise resources. The study underscores the advantages of leveraging existing hubs. Players like APCOA, the largest EU parking lot operator, are repurposing parking spaces to be used for e-cargo bike logistics and offering advantages such as the provision of parcel lockers, EV charging, car rental/sharing, etc. This approach facilitates cost-sharing among multiple "customers" who either share the same space or utilise the same services.

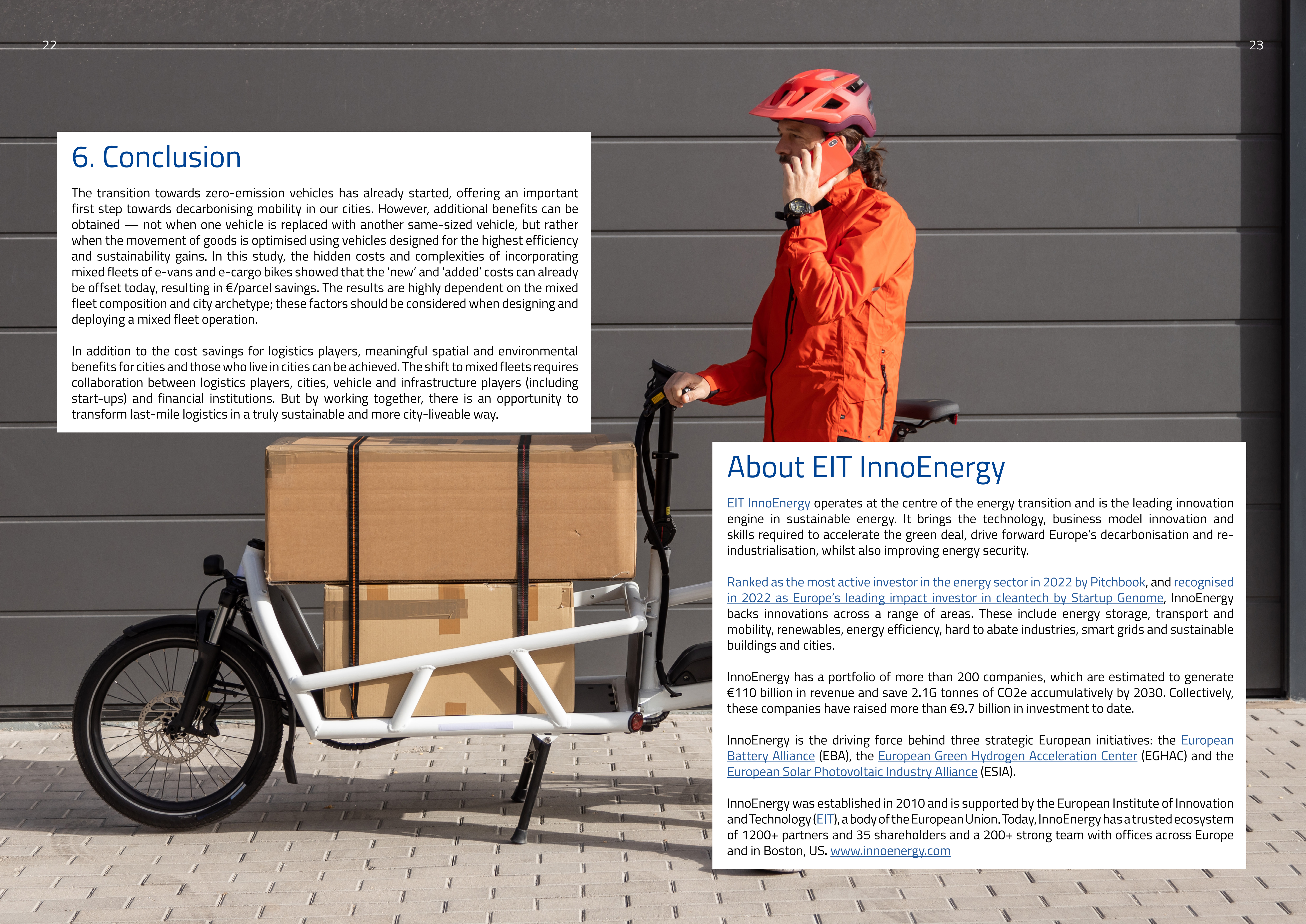
5.2. More People, More Operational Changes

To successfully implement changes in delivery operations, it is crucial to understand the challenges involved and **utilise data analytics to optimise routing.** Personnel costs account for 70–80% of the total costs. The shift to mixed fleets with e-cargo bikes emphasises the **importance of human resources management.** Introducing e-cargo bikes may initially cause productivity loss due to sorting and delivery process changes. Therefore, additional planning capacity is required, including a concept for returns management and an approach to container loading.

Moreover, the current tight labour market and the potential shortage of e-vans and drivers should be considered. Fortunately, since e-cargo bike delivery does not require specific licences for riders, filling these positions may be easier than filling van driver positions.

5.3. Tailored Last-mile Delivery to Specific Urban Conditions

Each city represents unique urban challenges and opportunities, requiring a **comprehensive understanding of the viable delivery zones for both e-cargo bikes and e-vans.** This involves not only identifying the division between B2C and B2B delivery zones, but also carefully defining the distribution of MFCs based on population density and parcel demand, and considering equally critical factors such as infrastructure, road conditions, topography, and seasonal changes like extreme heat or snowfall. By understanding these key city characteristics, both logistics operators and municipal governments can develop efficient distribution systems tailored to each city district and urban landscape.



6. Conclusion

The transition towards zero-emission vehicles has already started, offering an important first step towards decarbonising mobility in our cities. However, additional benefits can be obtained — not when one vehicle is replaced with another same-sized vehicle, but rather when the movement of goods is optimised using vehicles designed for the highest efficiency and sustainability gains. In this study, the hidden costs and complexities of incorporating mixed fleets of e-vans and e-cargo bikes showed that the 'new' and 'added' costs can already be offset today, resulting in €/parcel savings. The results are highly dependent on the mixed fleet composition and city archetype; these factors should be considered when designing and deploying a mixed fleet operation.

In addition to the cost savings for logistics players, meaningful spatial and environmental benefits for cities and those who live in cities can be achieved. The shift to mixed fleets requires collaboration between logistics players, cities, vehicle and infrastructure players (including start-ups) and financial institutions. But by working together, there is an opportunity to transform last-mile logistics in a truly sustainable and more city-liveable way.

About EIT InnoEnergy

EIT InnoEnergy operates at the centre of the energy transition and is the leading innovation engine in sustainable energy. It brings the technology, business model innovation and skills required to accelerate the green deal, drive forward Europe's decarbonisation and re-industrialisation, whilst also improving energy security.

Ranked as the most active investor in the energy sector in 2022 by Pitchbook, and recognised in 2022 as Europe's leading impact investor in cleantech by Startup Genome, InnoEnergy backs innovations across a range of areas. These include energy storage, transport and mobility, renewables, energy efficiency, hard to abate industries, smart grids and sustainable buildings and cities.

InnoEnergy has a portfolio of more than 200 companies, which are estimated to generate €110 billion in revenue and save 2.1G tonnes of CO2e accumulatively by 2030. Collectively, these companies have raised more than €9.7 billion in investment to date.

InnoEnergy is the driving force behind three strategic European initiatives: the European Battery Alliance (EBA), the European Green Hydrogen Acceleration Center (EGHAC) and the European Solar Photovoltaic Industry Alliance (ESIA).

InnoEnergy was established in 2010 and is supported by the European Institute of Innovation and Technology (EIT), a body of the European Union. Today, InnoEnergy has a trusted ecosystem of 1200+ partners and 35 shareholders and a 200+ strong team with offices across Europe and in Boston, US. www.innoenergy.com

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