URBANIZED
MODULAR AND FLEXIBLE SOLUTIONS FOR URBAN-SIZED ZERO-EMISSIONS LAST-MILE DELIVERY & SERVICES VEHICLES

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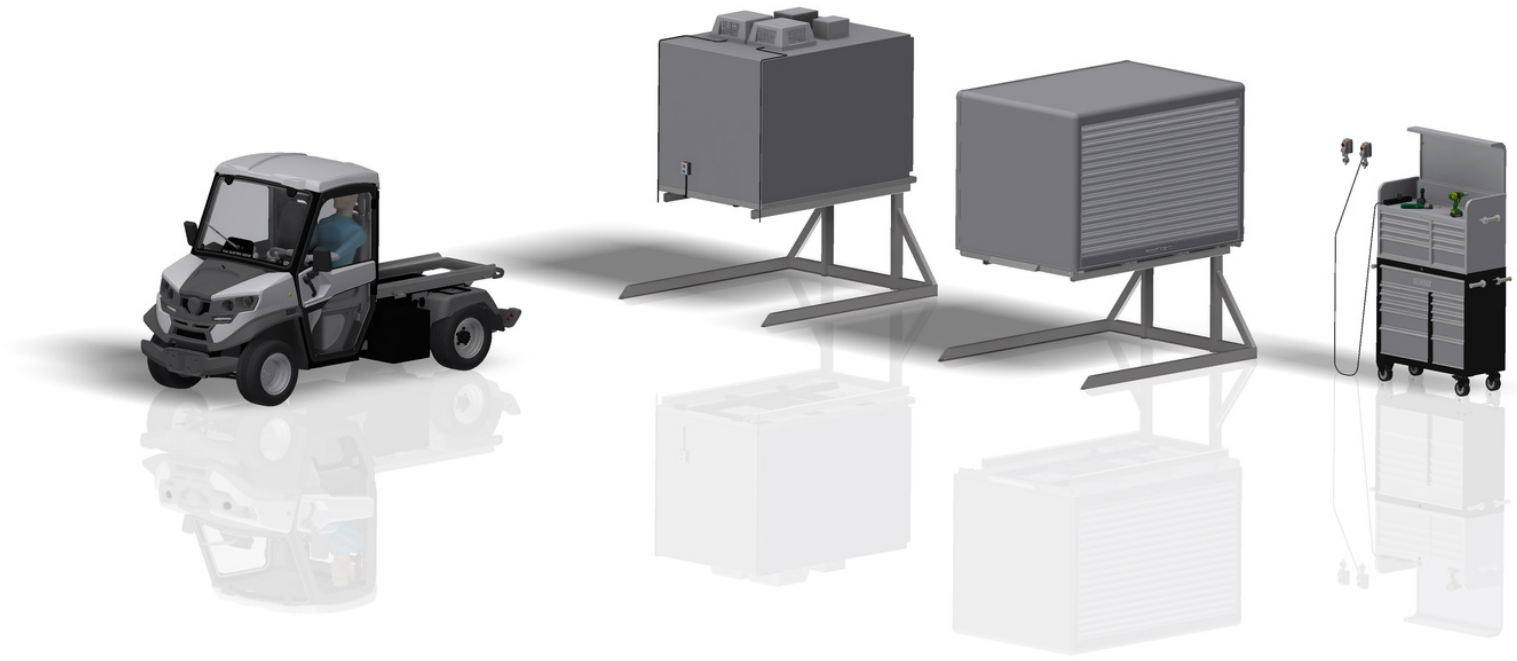

POSITION PAPER

OCTOBER 2023

THE URBANIZED VISION FOR MODULAR COMMERCIAL VEHICLES FOR FUTURE URBAN LOGISTICS

This publication was compiled and authored by Bax & Company on behalf of the Horizon 2020 funded URBANIZED project.

URBANIZED aims to future proof urban-readiness by solving the trade-offs between “one size fits all” and “design for purpose” approaches to sustainable last-mile delivery in the design of modular all-electric LCVs.

We develop and demonstrate the next generation of modular vehicle architectures for urban-sized commercial e-vehicles, satisfying design principles of optimisation and right-sizing vehicles for their mission.

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This position paper was written in consultation with Fernando Liesa (ALICE)

Executive summary

To be considered truly sustainable, logistics should be zero-emission, safe for everyone, and with a low impact on urban space, while fulfilling the demands of citizens and businesses. However, current urban logistics still require much development and innovation to reach a sustainable state.

The URBANIZED consortium considers that modular vehicles are a key enabling technology in the transformation towards sustainable urban logistics. Modular vehicles can allow for a wider variety of innovative logistics models while increasing efficiency and reducing redundancy for fleet owners.

Although the technology for modular vehicles and their logistics models is ready to be scaled up, large gaps still exist in terms of the market, policy, societal and organisational readiness.

To fully leverage the potential of modular vehicles, the following aspects are required:

1. Appropriate policy to facilitate:
    - long-term strategic clarity for logistics operators and companies.
    - space to innovate new logistics models.
    - acquisition of innovative delivery vehicles
    - public-private cooperation for knowledge sharing, collaboration, and partnerships
2. Research and trials to develop and validate the integration of modular vehicles and innovative logistics models, accessible to all logistics stakeholders.

Given the European commitments for carbon neutrality by 2050, we believe that modular solutions play an important role to support the transition in urban logistics. Nonetheless, the multifaceted approach needed, which includes awareness raising, streamlining regulations, encouraging collaboration and data sharing, requires both public and private stakeholders to work together. URBANIZED is taking the first steps in this direction.

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URBANIZED solutions for sustainable urban logistics

In the current state, urban logistics is polluting, disproportionally unsafe and space demanding. In urban areas, freight is responsible for 15-25% of all vehicle kilometres travelled, 20-40% of urban transport-related CO2 emissions, it occupies 20-40% of motorised road space[1], and emits 30-50% of other transport-related pollutants (PM, NOx, etc.)[2].

Figure 1: Visualising the current state of urban logistics.

Given the increasing consumption patterns, the rise of e-commerce and the limited implementation of ambitious policies, this will only worsen if current logistics operations are not improved. Following the COVID-19 pandemic, e-commerce deliveries have increased by 25% worldwide, leading to an upward trend of last mile deliveries. Moreover, by 2030 the overall last-mile delivery vehicle fleet is set to increase by 36% in the top 100 cities worldwide. This could lead to a 32% increase in emissions caused by delivery traffic and an increase in congestion of 21%, causing a potential additional commute time of 11 minutes for each passenger every day[3].

In this context, POLIS and ALICE's zero-emissions logistics guide underlines the need for interventions to achieve 1) clean fleets and 2) improved logistics operations[4]. Similarly, the new EU Urban Mobility framework calls for acceleration in the deployment of zero-emission solutions, technologies, and vehicles for urban logistics[5]. Importantly, clean fleets should have a positive economic impact as a result of lower maintenance costs, as well as increased efficiency in congested city centres.

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[1] Smart Freight Centre. (2017). Developing a Sustainable Urban Freight Plan-a review of good practices. https://www.smartfreightcentre.org/pdf/Developing-a-Sustainable-Urban-Freight-Plan-a-review-of-good-practices-SFC-Final-June2017.pdf

[2] ERTRAC, & ALICE. (2014). *Urban Freight research roadmap*. https://www.ertrac.org/wp-content/uploads/2022/07/ERTRAC_Alice_Urban_Freight.pdf

[3] World Economic Forum. (2020). The Future of the Last-Mile Ecosystem. https://www.weforum.org/reports/the-future-of-the-last-mile-ecosystem/

[4] POLIS, & ALICE. (2021). Guide for advancing towards zero-emission urban logistics by 2030. www.etp-alice.eu. https://www.etp-logistics.eu/wpcontent/uploads/2021/12/POLIS_ALICE_Guide-Zero-Emission-Urban-Logistics_Dec2021-low.pdf

[5] The New EU Urban Mobility Framework, (2021) (testimony of European Commission). https://eur-lex.europa.eu/legalcontent/EN/TXT/?uri=CELEX%3A52021DC0400&qid=1623311742827

The adoption of zero-emission vehicles requires more use of Urban Consolidation Centres[6], as well as 'mobility and logistics concepts, services, solutions and business models to make zero tailpipe emission vehicles affordable and usable in a wide range of applications[7].' Not only is the adoption of new technologies and services important to increase uptake of zero-emission vehicles, it also serves as a potential successful long-term measure to increase the resilience of mobility in cities[8].

An urban consolidation centre (UCC) is a logistics facility used to combine deliveries of multiple shippers for reducing freight traffic in dense urban areas.

The URBANIZED Project aims to innovate both clean fleets and logistics operations through a modular design, allowing for multi-purpose vehicles. The N1 vehicle class, to which the URBANIZED vehicle belongs, is complementary to other small and electric vehicle classes in urban logistics. Other delivery vehicles emerging in the light and electric class such as cargo bikes, generally exhibit reduced load capacity, range, speed, safety and comfort for drivers. While these vehicles offer substantial benefits in some respective areas, (i.e. cargo bikes may still be allowed in pedestrian areas), there are many scenarios where the URBANIZED vehicle class can complement delivery fleets.

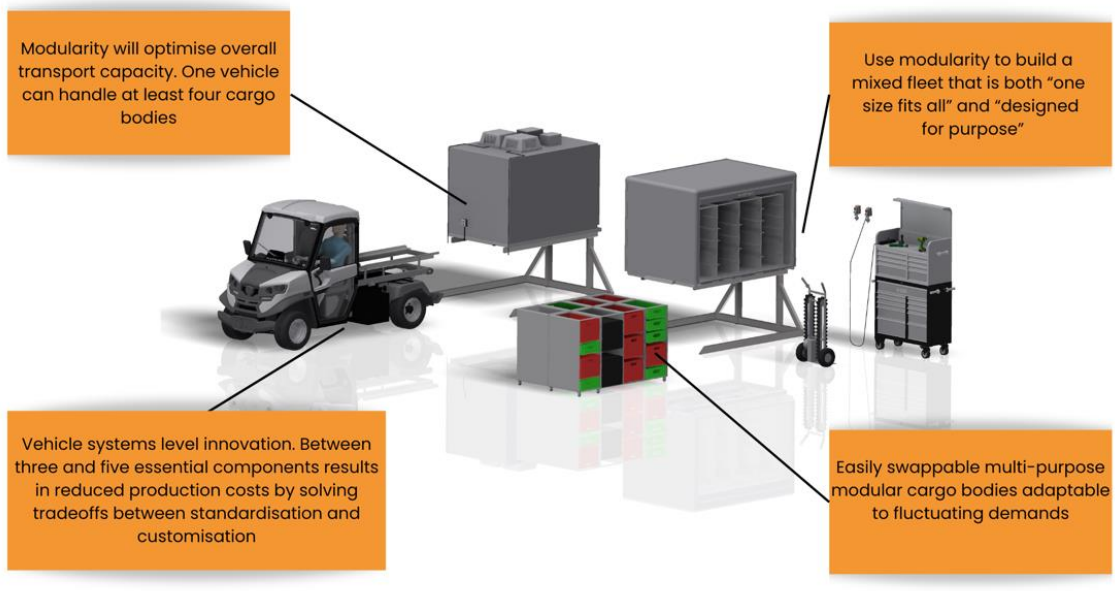


Figure 2: Summary of URBANIZED innovations.

[6] POLIS, & ALICE. (2021). Guide for advancing towards zero-emission urban logistics by 2030. www.etp-alice.eu. https://www.etp-logistics.eu/wpcontent/uploads/2021/12/POLIS_ALICE_Guide-Zero-Emission-Urban-Logistics_Dec2021-low.pdf

[7] 2ZeroPartnership. (2020). Draft proposal for a European Partnership under Horizon Europe Towards zero emission road transport. https://www.eralearn.eu/documents/final_report_ms_partnerships.pdf

[8] ERTRAC. (2021). Urban Mobility Resilience Roadmap. https://www.ertrac.org/wp-content/uploads/2022/07/ERTRAC-Urban-Mobility-Resilicience-Roadmap-V3.pdf

Modular delivery vehicles – key enabling technology for sustainable logistics

In the rapidly changing environment of last-mile delivery, logistics operators must adapt to new logistics and business models. Currently, incumbent logistics operators are trialling innovations in their operations, and start-ups are proposing disruptive innovations through the introduction of logistics models that include new vehicles and novel interactions with both customers and staff. Here, modular delivery vehicles can enable a wider variety of innovative logistics models and allow fleet owners to reduce redundancy as well as increase efficiency.

Modular vehicles enable a wider variety of innovative logistics models

Trialling new logistics models, so far at small scale, has mostly been conducted using vehicles with fixed cargo-bodies. Modular cargo-bodies could enable a wider variety of possibilities. **The key lies in the simple yet effective ability to remove the cargo-body from the vehicle frame and rapidly attach a different type of cargo-body (i.e. within minutes)**. **Shared** and **reverse logistics** are the most interesting logistics models to apply modular vehicles to, facilitating existing ideas and enabling ideation of additional novel logistics concepts.

Shared last-mile logistics services are undergoing a renewed emergence, pushed by city regulations and government support alongside evolving customer demands for sustainable delivery (see the Antwerp-based CULT community for example[9]). This type of delivery could benefit greatly from modular cargo-bodies by reducing fleet sizes and increasing flexibility to on-board a variety of logistics operators from different logistics streams, hence improving economic viability, an often-crucial aspect. Having one vehicle with a variety of cargo-bodies would enable shared logistics operators to buy a relatively small number of vehicles and operate a larger selection of cargo-bodies that can adapt according to the market and capacity required.

> The Physical Internet proposes to pool resources and assets in open, connected, and shared networks so they can be used seamlessly by network users and partners. The Physical Internet includes transport, storage and physical handling operations of load units such as containers, swap-bodies, pallets, boxes, etc., and any other resource needed for a freight transport and logistics operation.

Reverse logistics can Benefit from creating an additional consolidation point at the delivery location, particularly in business-to-business operations. A well-known example for business-to-consumer models is the parcel locker, which allows customers to return their packages. A wide range of options is possible if customers or businesses are willing to contribute to this form of circular economy. Think, for example, of clothing stores that pre-

[9] Collaborative Urban Logistics & Transport. https://www.cultcitylogistics.be/

package their returned clothes in a designated modular cargo-body, or restaurants and supermarkets that collect left-over food in a refrigerated cargo-body.

Solutions to reduce redundancy and increase efficiency

Firstly, **multi-purpose fleet operators can benefit most from swappable and modular cargo-bodies.** Logistics demands tend to vary over time, requiring efforts from logistics operators to rightsize their fleets, a difficult task[10]. It can lead to acquiring redundant transport capacity (i.e. vehicles) to accommodate peak demands, creating overall fleet under-utilisation. Through the use of a singular vehicle with multiple cargo-bodies, fleets could be rightsized more flexibly. Multi-purpose fleet operators such as leasing companies, municipal services, and HoReCa suppliers can especially benefit from this innovation, interchanging a single vehicle in-between multiple logistics purposes over time.

Secondly, **modular vehicles can reduce the total carbon footprint of the electrification of transport, through the rightsizing of fleets.** The electrification of delivery vans is an agreed-upon measure to reduce the total environmental impact of last-mile delivery, backed by the EU Parliament's proposal to ban the sale of petrol and diesel vans by 2035[11]. However, replacing the same last-mile delivery car park with battery-electric vehicles still poses negative externalities. The material demand of EV batteries has shown to put a strain on global supply chains and areas surrounding the mining operations of their raw materials[12]. Here, by enabling the rightsizing of fleets, modular vehicles can reduce the negative externalities posed by EV batteries.

Lastly, existing logistics streams can innovate through **swifter trans-shipment at their warehouses.** As last-mile delivery vehicles are becoming smaller and deliveries more on-demand, pre-filling modular cargo-bodies at warehouses could substantially increase operational efficiency. Thereby, idle time at warehouses can be reduced, which is especially useful for delivery vehicles that perform multiple delivery rounds each day. Here, using the Physical Internet principles of modularising loading units, trans-shipment has the potential to become even more efficient.

Recommendations for effective uptake

Although some pilots have been carried out with containerised last-mile delivery vehicles in the past, the full potential has not yet passed the research stage. **Although the technology**

[10] Towill, D. R. (2005). The impact of business policy on bullwhip induced risk in supply chain management. International Journal of Physical Distribution and Logistics Management, 35(8), 555–575. https://doi.org/10.1108/09600030510623339

[11] European Parliament. (2023). Reducing car emissions: new CO2 targets for cars and vans explained | News | European Parliament. https://www.europarl.europa.eu/news/en/headlines/society/20180920STO14027/reducing-car-emissions-new-co2-targets-for-cars-and-vans-explained

[12] Tidblad, A. A., et al. (2021). Future Material Developments for Electric Vehicle Battery Cells Answering Growing Demands from an End-User Perspective. Energies 2021, Vol. 14, Page 4223, 14(14), 4223. https://doi.org/10.3390/EN14144223

is mostly ready for scaling up and tailoring to specific market demands, large gaps still lie in the market, policy, societal and organisational readiness for modular vehicles and their logistics models. Looking across these pillars, there is a need for smart public-private collaboration and room for experimentation.

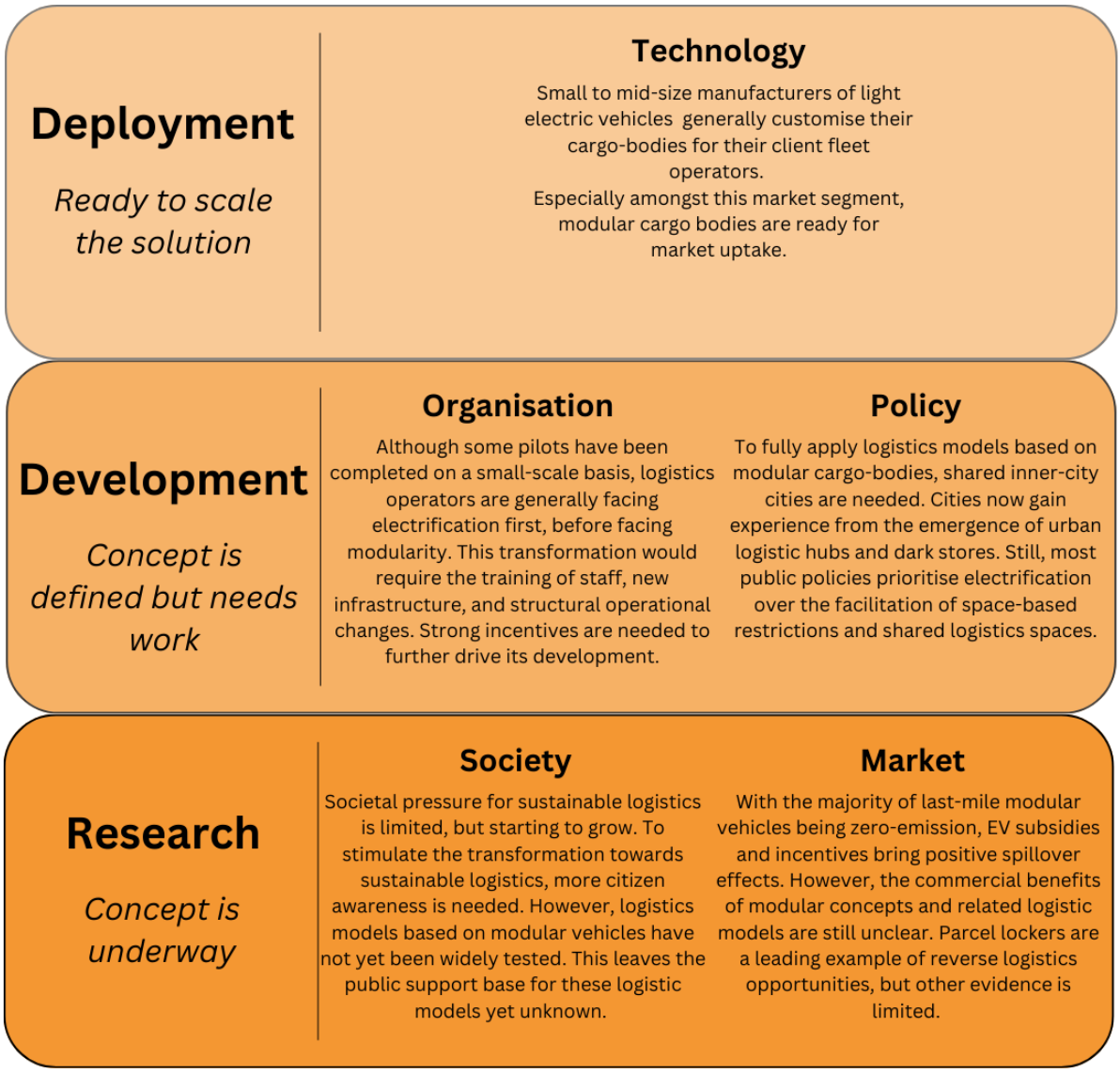


Figure 3: Solution readiness of modular vehicles

Policy steps

There are several actions that would facilitate the adoption of modular vehicles both directly and indirectly. So far, all developed modular light commercial vehicles have been zero-

emissions, and with the EU 2035 ban[13] on the sale of petrol and diesel vans, we expect manufacturers to continue developing modular last-mile delivery vehicles solely with zero emission powertrains. Thus, indirectly, actions proposed to stimulate electric Light Commercial Vehicles will also benefit the adoption of modular vehicles. **We recommend the following steps to support the integration of modular vehicles with last-mile logistics:**

- Providing **financial support, research funding and other real estate support to shared logistics city hubs.** Municipal and governmental subsidies or other financial support during the development stage could give shared city hub developers time to scale operations, aiming to gain sufficient logistics volume, thereby ensuring economic feasibility. Where many logistics city hubs in the past have not survived past the subsidised start-up phase[14], the increased emergence of Zero Emission Zones could ensure their financial viability. Moreover, there is a need for infrastructure plans that serve both logistics and other local needs. This requires more research and development towards the use of brown fields, architectural and urban integration of logistics facilities, as well as business models of shared logistics hubs[15]. Seeing the significant influence of (the lack of) public policies on logistics development in urban areas[16], policy trials could, for example, be run to stimulate brown field development.

- Smart **collaboration between logistics operators and city planners should enable cities to design more effective and innovative policies**, needed for the conceptualisation and validation of new logistics models (including those based on modular vehicles). One key step forward is the integration of Sustainable Urban Mobility Plans (SUMPs) with Sustainable Urban Logistics Plans (SULPs), as also mentioned in the New EU framework for Urban Mobility[17]. These are often developed separately, underrepresenting logistics stakeholders and under-exploiting synergies between personal mobility and logistics. Through the development and execution of these mobility plans, logistics stakeholders can bring added value by sharing data and engaging in city trials.

- **Clarity on Urban Vehicle Access Regulation (UVAR)** policies, as well as financial incentives for purchasing electric delivery vehicles. With increasing numbers of UVARs emerging, logistics operators must know precisely what they entail for future fleet and operational planning. As described by the Sustainable Urban Logistics Plan

[13] European Parliament. (2023). Reducing car emissions: new CO2 targets for cars and vans explained | News | European Parliament. https://www.europarl.europa.eu/news/en/headlines/society/20180920ST014027/reducing-car-emissions-new-co2-targets-for-cars-and-vans-explained

[14] Kin, B., Verlinde, S., Van Lier, T., & Macharis, C. (2016). Is there Life after Subsidy for an Urban Consolidation Centre? An Investigation of the Total Costs and Benefits of a Privatelyinitiated Concept. Transportation Research Procedia, 12, 357–369 https://doi.org/10.1016/j.trpro.2016.02.072

[15] ERTRAC, ERRAC, & ALICE. (2017). Integrated Urban Mobility Roadmap. https://www.ertrac.org/wp-content/uploads/2022/07/2017-ERTRAC-Urban-Mobility-Roadmap-web.pdf

[16] Schorung, M., Dablanc, L., & Buldeo Rai, H. (2023). Urban and Suburban Logistics Real Estate - Logistics City.

[17] The New EU Urban Mobility Framework, (2021)(testimony of European Commission). https://eur-lex.europa.eu/legalcontent/EN/TXT/?uri=CELEX%3A52021DC0400&qid=1623311742827

guidelines[18] it is good practice to involve logistics stakeholders in the early stages of decisionmaking. See for example Logistiek010, a logistics community driven by the municipality of Rotterdam to introduce their Zero-Emission Zone.[19]

- Policymakers should undertake action for the wide-scale deployment of both public and private charging infrastructure. As described by ALICE and POLIS' guidelines,[20] sufficient grid capacity is needed for full fleet electrification. An important policy step includes upgrading national electricity grid infrastructure plans, giving more consideration to freight needs. Here, shared ownership and services at city hubs are a promising way forward for many smaller logistics companies to collaborate, thereby allowing grid investments to be focused towards charging infrastructure for fewer, larger fleets.[21]

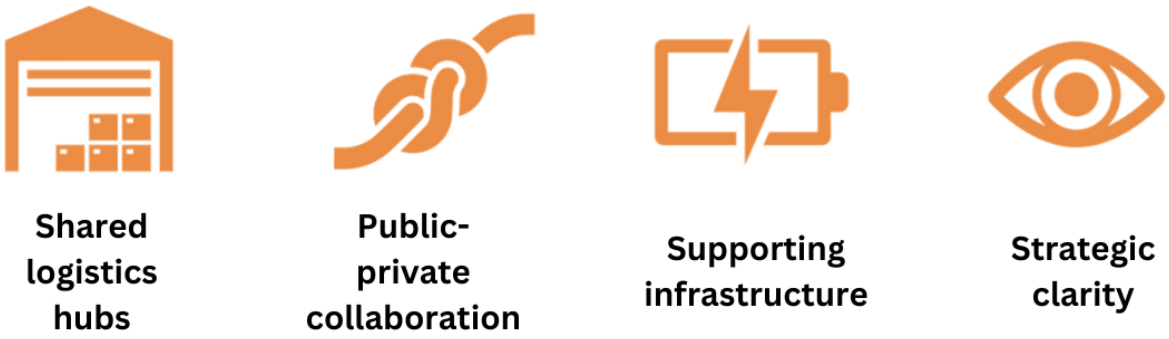


Figure 4: Policy recommendations for increased modular vehicle uptake

Research and trials

To advance the societal, market, organisational and policy readiness of modular vehicles, research and trials are needed to validate use cases and their potential to reduce fleet size and cost. The implementation of a new delivery vehicle into a fleet goes hand in hand with a sound logistics model. The complexity for logistics operators to make this combination work is significant, considering aspects such as available capital, charging

[18] NOVELOG. (2019). Topic Guide: Sustainable Urban Logistics Planning. https://www.eltis.org/sites/default/files/sustainable_urban_logistics_planning_0.pdf

[19] Logistiek 010. (n.d.). Retrieved June 15, 2023, from https://logistiek010.nl/

[20] POLIS, & ALICE. (2021). Guide for advancing towards zero-emission urban logistics by 2030. www.etp-alice.eu. https://www.etp-logistics.eu/wpcontent/uploads/2021/12/POLIS_ALICE_Guide-Zero-Emission-Urban-Logistics_Dec2021-low.pdf

[21] Ploos van Amstel, W. (2023). Kleine transporteurs die elektrisch willen rijden? Moeten we dat wel willen? . https://www.waltherploosvanamstel.nl/kleine-transporteurs-dieelektrisch-gaan-rijden-moeten-we-dat-wel-willen/

strategies, customer demands, zero-emission zones, delivery windows and drivers' vehicle preferences.[22] This means that any adoption of a new delivery vehicle must be carefully considered. Furthermore, as described in ERTRAC's Urban Mobility Roadmap,[23] large-scale demonstrators should show the impact of logistics concepts, tools and innovations (such as modular vehicles) to city planners.

Specific attention points for research and trials include:

- Ensured interaction with the **end-user of vehicles and warehouse operations**, as well as the **cargo recipient and citizens**. Drivers within urban logistics have high levels of autonomy, and fleet managers generally listen to their needs and preferences. The same is true for cargo recipients and citizens, who will also be interacting with new logistics models spurred by modular vehicles. Here, co-developing modular vehicle concepts and logistics models could be a key development for their uptake.

- Focus on **equity amongst logistics stakeholders**. Smaller logistics operators (<5 employees) make up the majority (85%) of last-mile delivery companies.[24] SMEs in particular, will require support to transition towards zero-emission operations due to their capital, innovation and absorptive constraints. To fully transition towards sustainable urban logistics, it is vital that SMEs are involved. We foresee key steps in codeveloping support tools such as Total Cost of Ownership (TCO) calculations and awareness campaigns to interact with new delivery vehicles and new logistics models. These initiatives will take into account the needs and perspectives of smaller logistics companies.

- **Advanced logistics control systems and data sharing** frameworks are required to support shared and reverse logistics models, and simultaneously enable the Physical Internet vision.[25] This vision highlights that cross-sectoral and cross stakeholder data sharing is lacking in urban logistics, and there is a significant role for cities to initiate data-driven collaborations. Notably, innovative logistics models such as shared and reverse logistics require close collaboration between logistics operators as well as their recipients, requiring proper and trusted operating models where data can move more freely.

[22] Marthaler, L., & Axinte, L. (2022). The diversification of a logistics fleet– what does it mean for a manager? https://urbanized.eu/the-diversification-of-a-logistics-fleet-what-does-itmean-for-a-manager/

[23] ERTRAC, ERRAC, & ALICE. (2017). Integrated Urban Mobility Roadmap. https://www.ertrac.org/wp-content/uploads/2022/07/2017-ERTRAC-Urban-Mobility-Roadmap-web.pdf

[24] ERTRAC, & ALICE. (2014). Urban Freight research roadmap. https://www.ertrac.org/wp content/uploads/2022/07/ERTRAC_Alice_Urban_Freight.pdf

[25] ALICE. (2020). Roadmap to the Physical Internet. www.etp-alice.eu. https://www.etp-logistics.eu/wp-content/uploads/2022/11/Roadmap-to-Physical-Intenet-Executive-Version_Final-web.pdf

- Following the Physical Internet principles, the **standardisation of swappable cargobodies, packaging and surrounding infrastructure** can allow for swifter transhipment across logistics nodes. As mentioned in ALICE's roadmap to Physical Internet[26], the interaction between loading units (such as swap bodies and pallets), are far from standardised across logistics chains. The same applies to the packaging of goods and surrounding infrastructure (i.e. parcel lockers), which together with standardised swap bodies could harmoniously facilitate the efficient flow of goods between logistics nodes. Thus, it is recommended to focus project research and trials, as well as further vehicle specifications, towards the integration of universal PI container designs throughout supply chains.

- **Knowledge transfer of urban logistics best practices** across Europe. The development of SUMP and SULPs across Europe, partially funded by the European Union, presents a window of opportunity to allow for a spread of best practices by transport professionals. Once the benefits are demonstrated through more research and trials, the EU could be more prescriptive with SULPs to also refer to modularity (i.e., via the SULP topic guide[27]). It is important for decision makers to understand what the best practices are across a variety of city typologies[28].

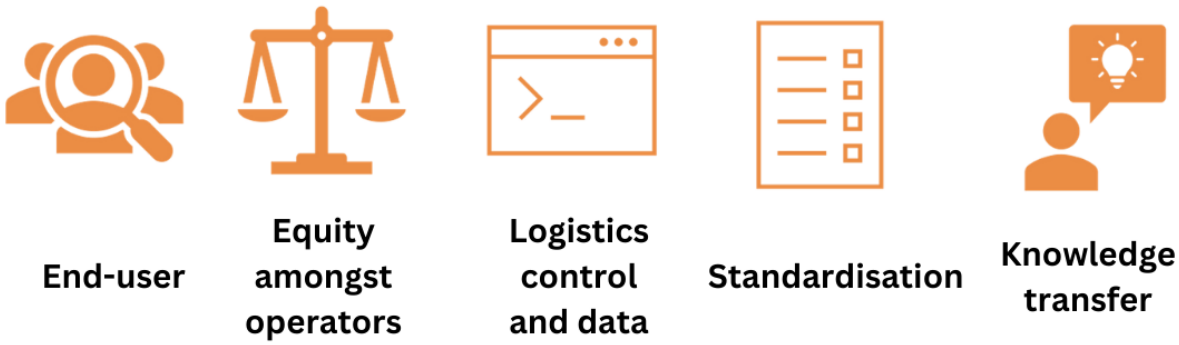


Figure 5: Recommendations for trials and demonstrations

[26] ERTRAC, & ALICE. (2014). Urban Freight research roadmap. https://www.ertrac.org/wp-content/uploads/2022/07/ERTRAC_Alice_Urban_Freight.pdf

[27] NOVELOG. (2019). Topic Guide: Sustainable Urban Logistics Planning. https://www.eltis.org/sites/default/files/sustainable_urban_logistics_planning_0.pdf

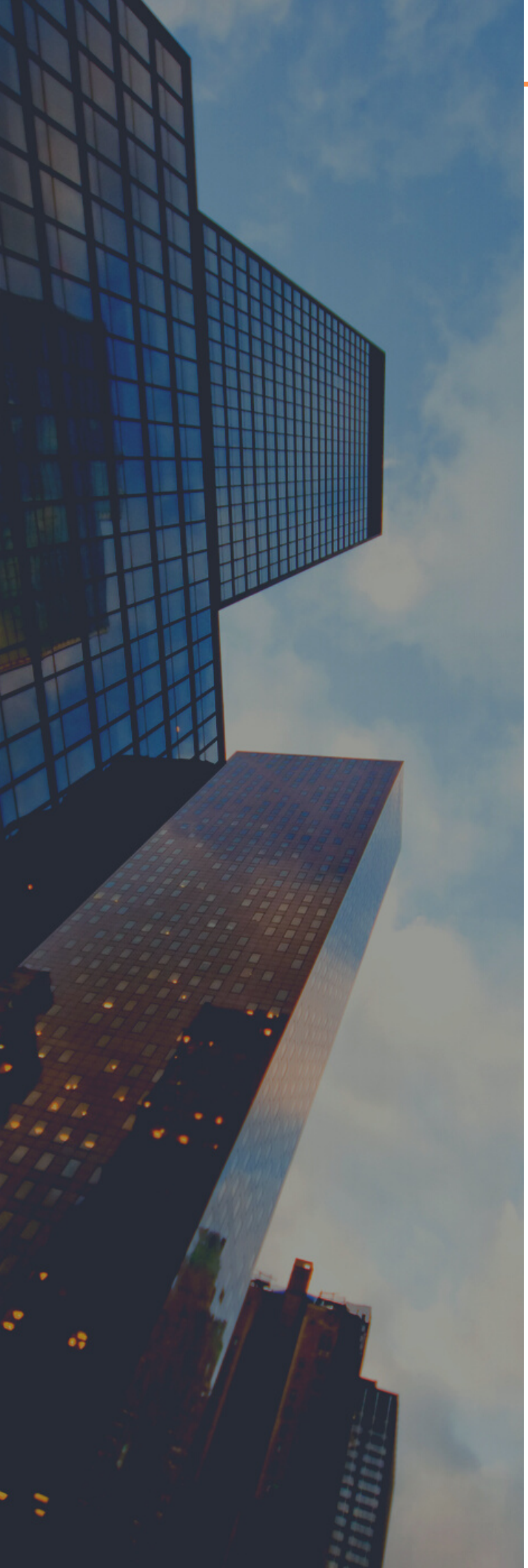
[28] ERTRAC, ERRAC, & ALICE. (2017). Integrated Urban Mobility Roadmap. https://www.ertrac.org/wp-content/uploads/2022/07/2017-ERTRAC-Urban-Mobility-Roadmap-web.pdf

Conclusion

We see a strong opportunity for modular vehicles to become one of the enablers of the transformation towards sustainable logistics through incrementally improving the efficiency and reducing redundancy of current fleet operations, as well as supporting more radical logistics models.

There is a need for public and private stakeholders to collaborate and jointly drive innovation. Currently, the ongoing incoordination between logistics stakeholders and governmental bodies is hampering innovation.

Policymakers have the opportunity to create the optimal environment for logistics stakeholders to innovate and achieve more sustainable logistics. In turn, logistics operators can enable effective policymaking by sharing insights and data, as well as trialling logistics models that may at first seem too far from business as usual.



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