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Greener Micromobility

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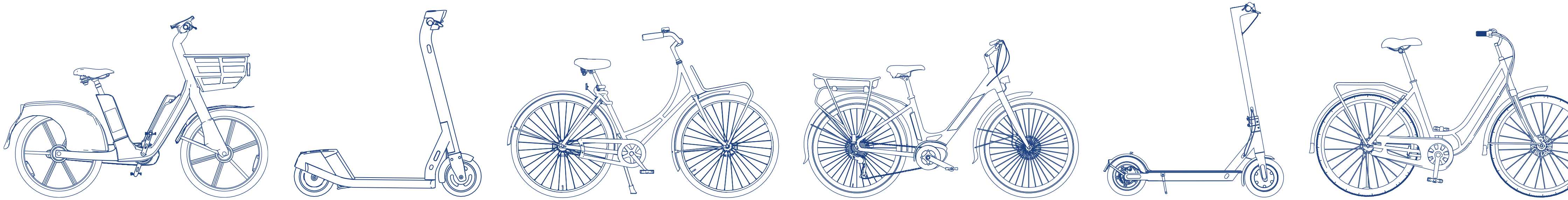


Greener Micromobility

Contents

Micromobility is becoming greener

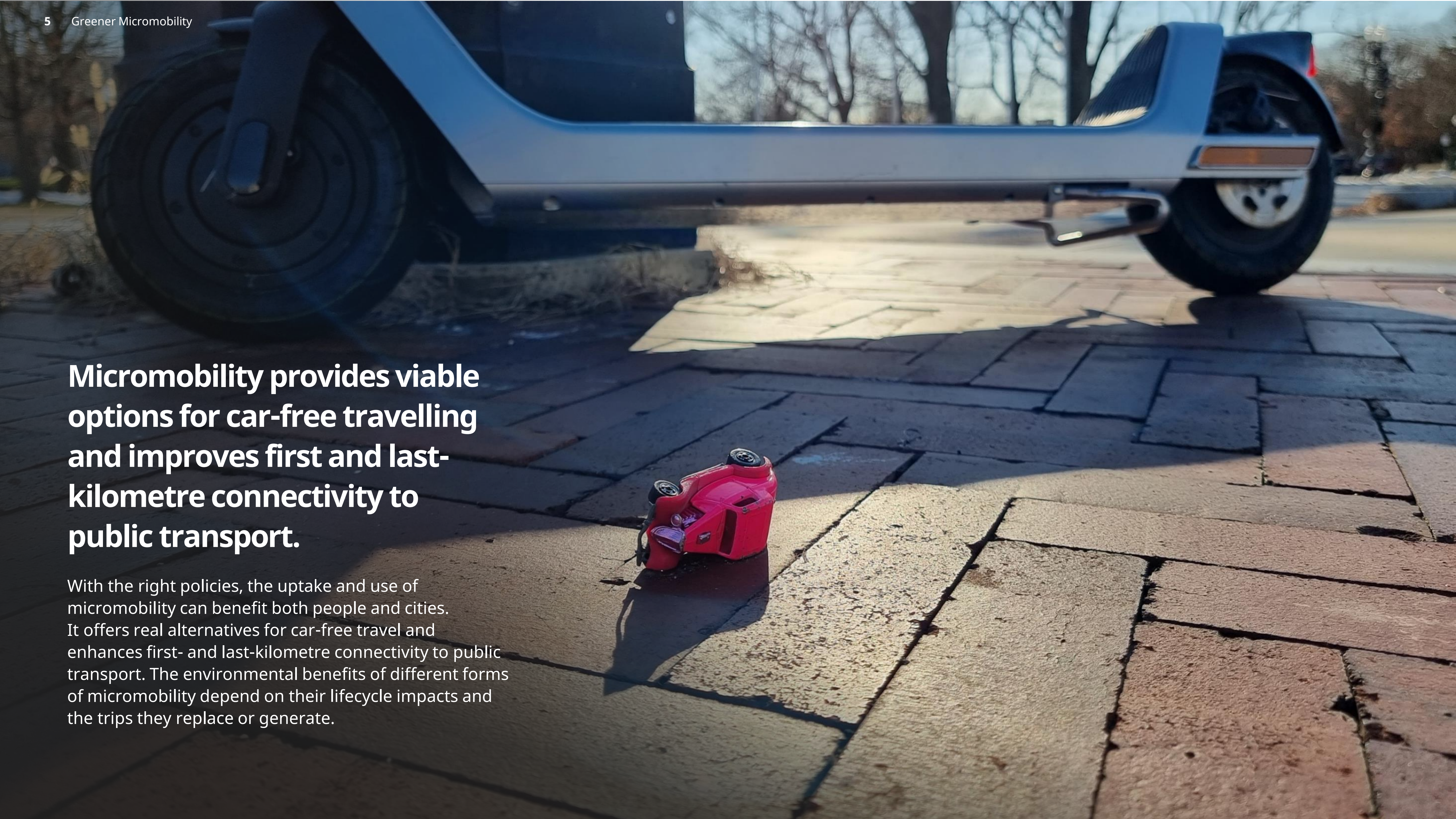
Aside from walking, cycling remains the most environmentally friendly way of moving around cities. Electrification has further expanded the distances cyclists can travel. Shared micromobility has made significant progress in terms of sustainability as operators have addressed the impacts of their fleets and operations on the environment. Leasing models are particularly attractive from a lifecycle environmental impact perspective.

Shared fleet vehicle design has reduced lifecycle impacts

The rapid uptake of improved vehicle designs in shared fleets has steeply reduced per-rider-kilometre greenhouse gas emissions. Longer vehicle lifetimes, enabled by more robust design, greater modularity and ease of repair, have driven reductions in impact across the lifecycle.

Fleet servicing operations have significantly improved

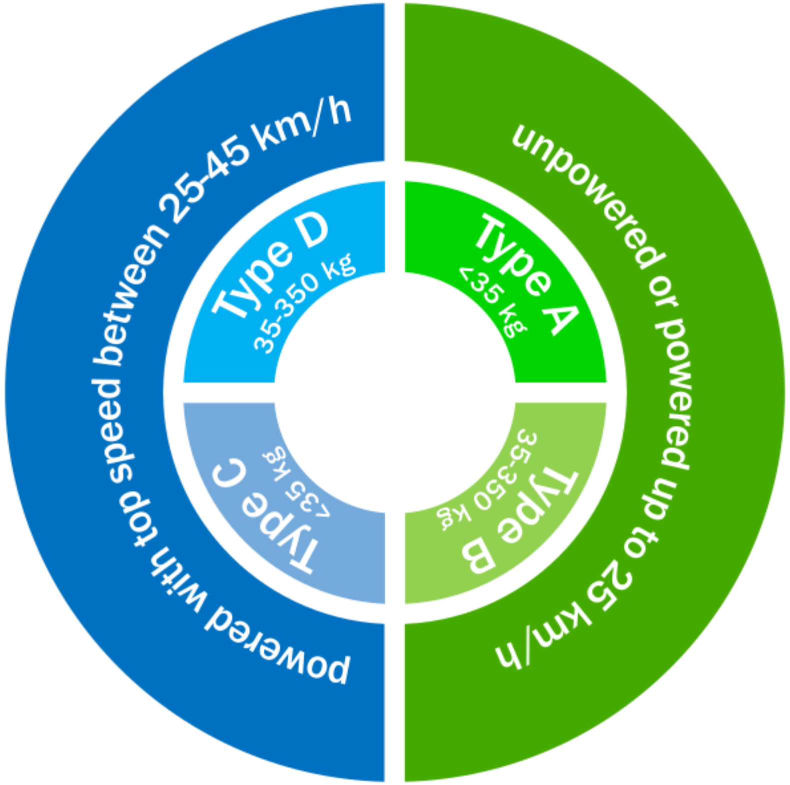
Swappable, higher-capacity batteries have reduced the impact of fleet recharging, enabled the use of less impactful cargo bikes and fostered more efficient fleet servicing models. Improved fleet logistics, including maintenance, repair and re-positioning have contributed to greener operations. Electrification of fleet servicing vans also matters, but to a lesser extent.



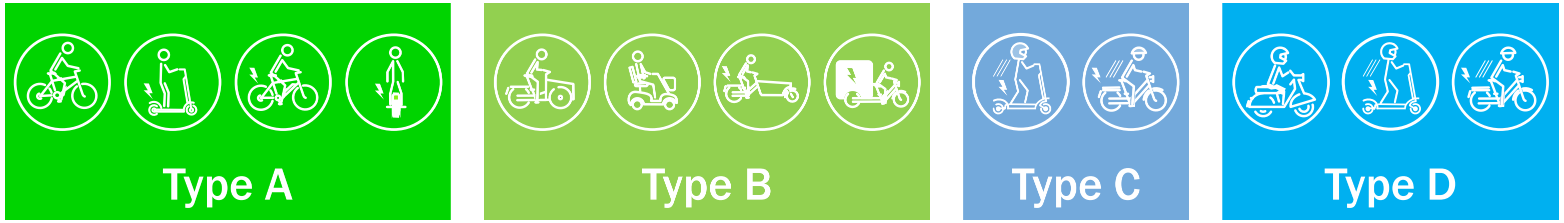
Micromobility provides viable options for car-free travelling and improves first and last-kilometre connectivity to public transport.

With the right policies, the uptake and use of micromobility can benefit both people and cities. It offers real alternatives for car-free travel and enhances first- and last-kilometre connectivity to public transport. The environmental benefits of different forms of micromobility depend on their lifecycle impacts and the trips they replace or generate.

What is micromobility?



This report focuses on bicycles, e-scooters and e-bikes weighing less than ~35 kg and with a motor-assisted speed of less than 25 km/h.



The term “micromobility” describes personal vehicles that are small and light. No standard definition of the term exists as micromobility partially intersects with or lies outside various vehicle classification or approval schemes used by public authorities or industry associations (e.g. the UN L-category for light motorised vehicles).

Micromobility plays an important role in daily mobility, whether on its own or in conjunction with other modes. Micromobility vehicles are popular in many contexts, suit many trip types and are more environmentally sustainable than heavier and larger vehicles.

Micromobility vehicles range from established modes (e.g. bicycles), to less established and rapidly evolving forms (e.g. standing or seated e-scooters, electric unicycles, etc.).

Some of these vehicles are approved for use on roads, others not. Some are allowed in pedestrian environments in some countries and cities but not in others.

Active micromobility vehicles, such as bicycles, pedal-assist e-bicycles, kick-scooters and skateboards, require human exertion to move, providing important health benefits. By contrast, other micromobility vehicles such as e-scooters, accelerate and move only with direct traction from a motor and do not generate direct health benefits.

There are several ways to classify micromobility, for example according to vehicle features or policy objectives. This report adopts the ITF’s generic approach to classifying micromobility from a safety perspective – an approach which is descriptive rather than normative.

Following the Safe System approach and highlighting two major crash severity parameters – speed and mass – the ITF framework identifies four broad micromobility vehicle types:

Type A: powered or unpowered vehicles weighing less than 35 kg and with a maximum powered design speed of 25 km/h.

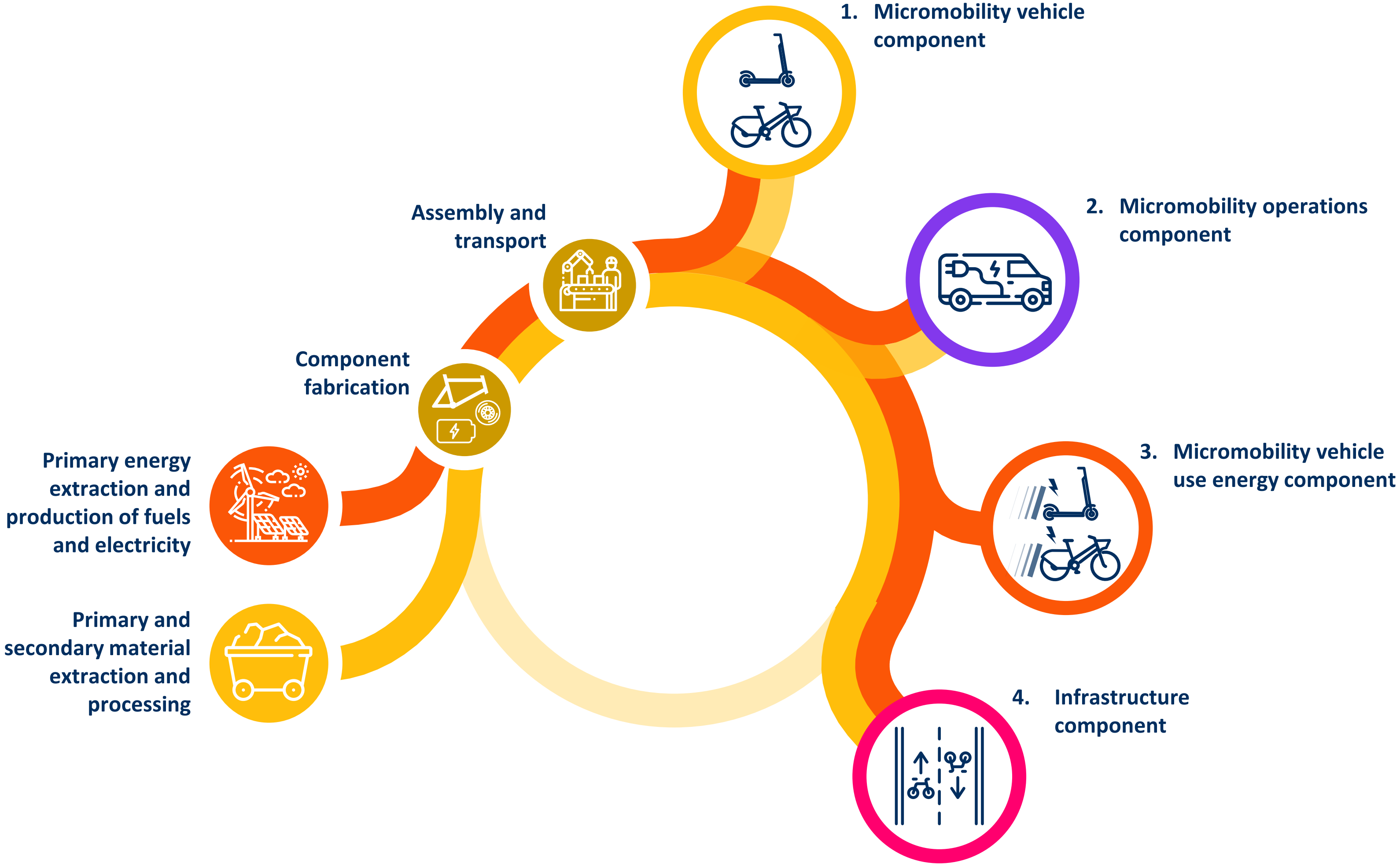
Type B: powered or unpowered vehicles weighing between 35 kg and 350 kg and with a maximum powered design speed of 25 km/h.

Type C: powered vehicles weighing less than 35 kg and with a design speed between 25 km/h and 45 km/h.

Type D: powered vehicles weighing between 35 kg and 350 kg and with a design speed between 25 km/h and 45 km/h.

This report focuses Type A and Type C vehicles as these comprise the most widespread micromobility form factors.

The four components of micromobility lifecycle impact assessment



This report's assessment of greenhouse gas (GHG) emissions from micromobility relies on the same methodological approach developed in the 2020 ITF report "Good to Go?". This approach is aligned with established lifecycle assessment reporting practices and is harmonised per rider kilometre. All data sources and calculations are available in the accompanying spreadsheet-based assessment tool.

The lifecycle assessment accounts for upstream primary energy extraction and production of fuels and electricity as well as primary and secondary material extraction and processing. The assessment tracks the use of energy and materials for the fabrication of vehicle components, and their assembly. It also accounts for the transport and logistics of materials and manufactured outputs.

This report identifies four broad categories of final lifecycle impacts:

1. Micromobility vehicle manufacturing, including material production, vehicle assembly and related energy use).
2. Material and energy required to service and reposition micromobility fleets (e.g. by vans or cargo bikes).
3. Direct energy used by electric micromobility vehicles, including upstream conversions and related primary energy extraction.
4. Materials and energy required to build infrastructure used by micromobility vehicles, attributed to different vehicle types based on their requirements and frequencies of infrastructure use.

What is the environmental impact of micromobility?

Bicycles have the lowest environmental impact but the environmental performance of shared micromobility has improved the most since the ITF’s 2020 assessment.

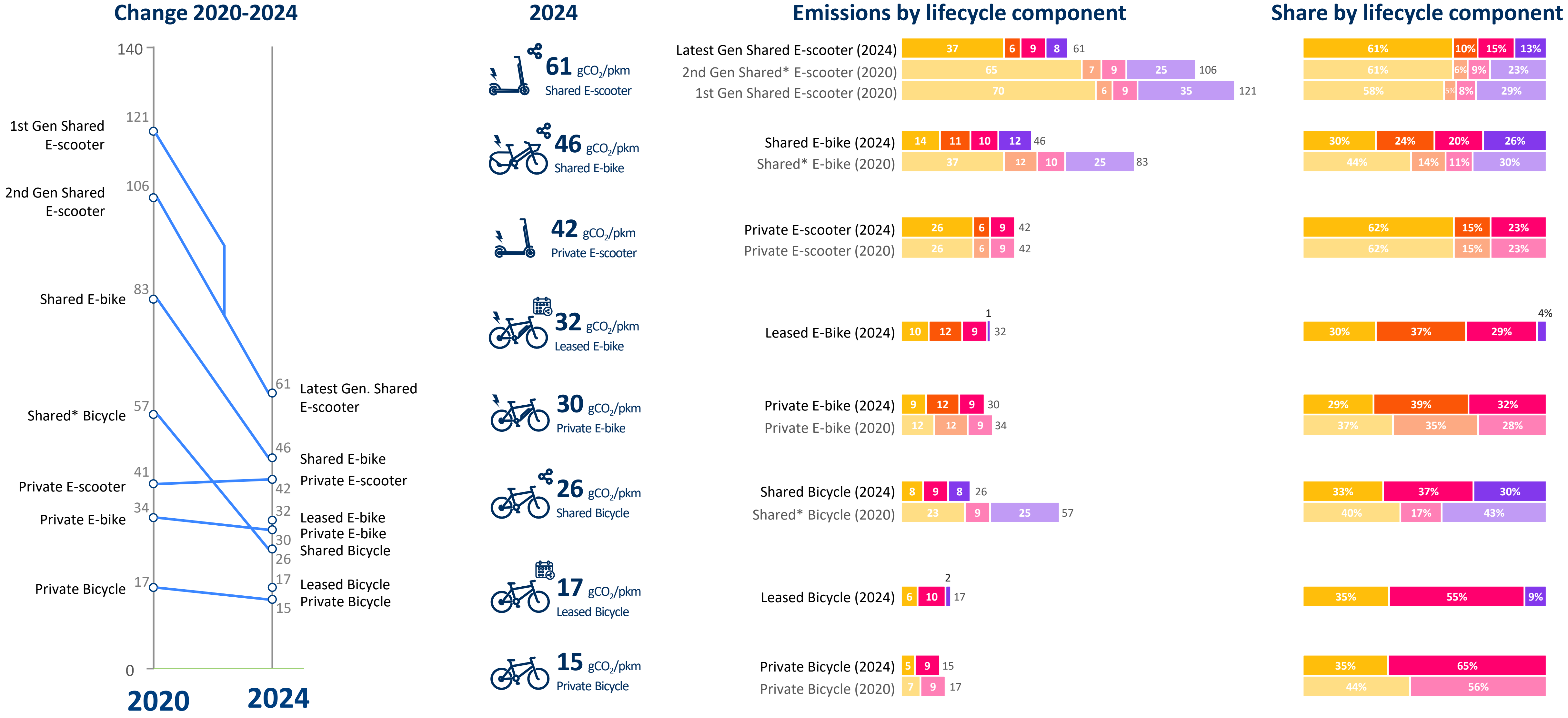
The lifecycle environmental impact of micromobility varies according to mode and use case but is low in comparison to cars and roughly comparable to public transport (Figure 1). Individually owned non-electric bicycles have the lowest environmental impact, followed closely by long-term leased non-electric bicycles. Electrically assisted modes have a higher environmental impact, linked to the production of batteries and motors as well as the electricity necessary to operate these vehicles. Shared micromobility introduces a new set of environmental impacts linked to fleet servicing, battery swapping and re-charging, and vehicle re-positioning.

The environmental impact of shared micromobility services has improved the most since the ITF’s 2020 assessment. This is largely due to the combination of greater awareness by industry stakeholders regarding the factors contributing to environmental impacts and the deployment of effective strategies to address them. Design improvements have led to more robust and durable shared micromobility vehicles and components. Operational practices have improved as well – especially due to a generalised shift to battery swapping versus a vehicle-focused “collect, charge and re-deploy” model. The rapid deployment of new swap-battery vehicle models in shared fleets has also contributed to decreased environmental impact.

Other improvements derive from lower carbon intensities of the global electricity mix and from the upward adjustment of battery capacities. These improvements come with greater manufacturing emissions but also enable longer periods between battery swapping, helping reduce servicing emissions.

Figure 1: Lifecycle CO_2 emissions for micromobility vehicles

Grams of CO_2 per passenger (rider) kilometre



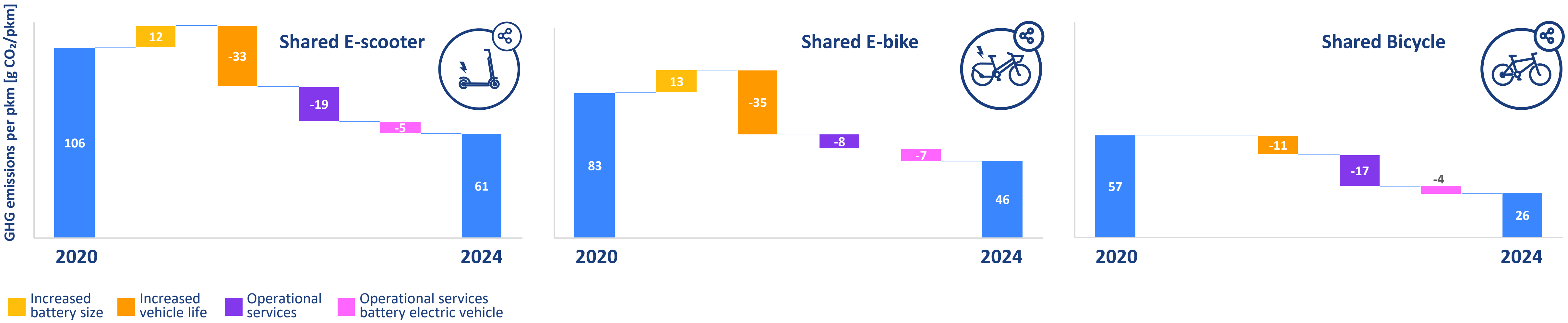
🟨 Vehicle component 🟧 Energy component 🟥 Infrastructure component 🟪 Operational services (70% BEV)

For reference

- 160 gCO2/pkm EU fossil fuel car (1.5 passengers)
- 91 gCO2/pkm EU battery electric car (1.5 passengers)
- 90 gCO2/pkm EU fossil fuel bus (15.3 passengers)
- 42 gCO2/pkm EU battery electric bus (15.3 Passengers)

Note: All shared bicycles, e-bikes and e-scooters are assumed to be dockless, Maintenance and repositioning vehicles assumed to be 70% battery electric vehicles (vans). All detailed calculations and sources available in accompanying spreadsheet tool. All emission figures rounded up to the nearest whole number.

Figure 2: How has shared micromobility improved its environmental impact?



Assuming a 70% electric vehicle share for maintenance, battery swapping, repositioning and other fleet operation purposes.

Shared micromobility services have all reduced their lifecycle greenhouse gas emissions in similar ways (see Figure 2) when considering vehicle lifetimes, operational improvements and servicing by battery electric vans (and cargo bikes).

Increased vehicle life has led to the greatest reduction in greenhouse gas emissions for shared electric bikes and e-scooters. These reductions stem partly from more durable vehicles, despite an increase in material use due to heavier and more robust vehicles. In addition, more modular vehicle architectures have made it possible to swap out damaged and used parts without needing to retire the entire vehicle. These improvements offset the environmental impact of increased battery weight and size.

The shift to swappable batteries and increased battery capacity has contributed to less frequent and more efficient micromobility vehicle servicing and charging operations. The servicing of shared non-electric bicycles has reduced environmental impacts as a result of more robust vehicles and better-optimised fleet redistribution models.

Additional greenhouse gas reductions come from a switch to electric vehicles for fleet support operations. The deployment of these vehicles has also proven to be cost-effective, as the servicing vehicles are heavily utilised. Nonetheless, their contribution to lifecycle greenhouse gas savings, in absolute terms, is a small fraction of what arises from lifetime extensions and other measures allowing improvements in servicing logistics.

Key drivers of improved lifecycle impact

Longer vehicle lifespans drive lifecycle greenhouse gas emission reductions from micromobility – especially for shared micromobility.

Longer vehicle lives drive reduced lifecycle greenhouse gas emissions from micromobility – especially for shared micromobility. Shared e-scooters, bicycles and e-bicycles have roughly tripled their useable lifespans since the ITF's 2020 assessment. As noted previously, this results from more durable and modular vehicle construction. But it also stems from better documentation of vehicle lifespans by industry stakeholders in their sustainability reports and other independent studies – particularly Dott (2023), Krauss et al. (2022), Voi (2023), Brightside (2022) and Superpedestrian (n.d.).

Travel distances for fleet servicing vehicles have been revised downward from the 2020 assessment, reflecting indications available from Severengiz et al. (2020) and Schünemann et al. (2021). The efficiency improvements made possible by battery swapping have reduced the operational footprint of shared micromobility and enabled smaller and more evenly distributed servicing facilities that can be closer to areas of intensive micromobility use.

The number of active micromobility vehicles per fleet servicing vehicle is significantly higher in this assessment than in the 2020 report. This reflects major efficiency gains as newer generations of e-scooters and e-bikes with swappable batteries have replaced first-generation vehicles with built-in batteries. This shift has enabled each fleet servicing vehicle to handle far more micromobility vehicles than in the initial phase of market deployment. It also reflects a decrease in the frequency of servicing interventions and battery swaps per active micromobility vehicle.

Key drivers of improved lifecycle impact (continued)

For shared non-electric bikes, the 2024 update also reflects an improved methodology for assessing servicing and fleet redistribution impacts.

Table 1 shows an increase in the estimated lifetime of personal bikes – based on ECF (2021). Longer lifetimes for leased bicycles are also assumed, although this business model was not assessed in the 2020 ITF report.

Available data indicates roughly similar or even slightly lower levels of daily travel per shared micromobility vehicle compared to pre-Covid travel volumes. Likewise, available data indicate little change in patterns of travel substitution or travel generation by micromobility.

Long-term micromobility leasing, added in this update and discussed in further detail below, is characterised by a high number of active bicycles (electric or otherwise) per servicing vehicle. This is due to the nature of the business model and the reduced need for servicing or theft replacement.

Table 1. Key assumptions underpinning micromobility lifecycle greenhouse gas emissions	Lifetime (vehicle) [years]	Annual mileage [km/year]	Lifetime km [km]	Vehicle weight [kg]	Battery capacity [kWh]	Travel requirement for vehicle providing operational services [service vehicle km/day]	Number of active vehicles per service vehicle [active vehicles/ service vehicle]
Private e-scooter (2020)	3.0	2200	6600	10.9	0.33	n.a.	n.a.
Shared e-scooter, first generation (2020)	0.8	2900	2417	10.9	0.33	90	80
Shared e-scooter, second generation (2020)	2.0	2900	5703	24.6	0.55	90	112
Private bike (2020)	5.6	2400	13440	20.6	n.a.	n.a.	n.a.
Shared bike (2020)	1.9	2900	5510	26.6	n.a.	45	56
Private e-bike (2020)	5.6	2400	13440	23.3	0.50	n.a.	n.a.
Shared e-bike (2020)	1.9	2900	5510	30.8	0.50	90	112
Private e-scooter (2024)	3.0	2200	6600	10.9	0.33	n.a.	n.a.
Shared e-scooter (2024)	4.8	2400	11520	24.6	1.00	70	249
Private bike (2024)	8.0	2400	19200	20.6	n.a.	n.a.	n.a.
Shared bike (2024)	6.0	2500	15000	26.6	n.a.	70	250
Leased bike (2024)	8.0	2500	20000	26.0	n.a.	70	1217
Private e-bike (2024)	8.0	2400	19200	23.3	0.50	n.a.	n.a.
Shared e-bike (2024)	6.0	3200	19200	30.8	1.00	70	124
Leased e-bike (2024)	8.0	3200	25600	30.5	1.00	70	1217

Source: This table is based on data available in Dott (2023), Krauss et al (2022), Voi (2023), Brightside (2022), Superpedestrian (n.d.), Severengiz et al. (2020), ING (2020), Swapfiets (2021), ECF (2021), Bolt (n.d.), Schünemann et al. (2021) and ITF (2020). It also draws on data referenced in this report's spreadsheet-based assessment tool and builds on responses to questionnaires filled by shared micromobility operators and personal communications by the authors. with them.

Long-term leasing: Low-impact sharing

Long-term leasing is particularly attractive from an environmental and consumer perspective.

Available data shows that long-term bicycle leasing models are particularly attractive from an environmental and consumer point of view – roughly on par with privately owned bicycles or e-bikes.

Key data sources used to develop the assessment of their characteristics include Île-de-France Mobilités (2022), Swapfiets (2021) and ING (2020). Cycling data regarding user behaviour are taken from ECF (2021), considering similar circumstances regarding personal bikes.

The analysis assumes longer lifetimes for leased micromobility vehicles than for shared bikes and comparable to personal bikes. This choice attempts to reflect the strong emphasis placed on lifetime extension, good maintenance and economic circularity (aligned with the longer use of existing materials) in Swapfiets (2021), Swapfiets (n.d. a), Swapfiets (n.d. b) and Swapfiets (2022).

Leasing models display a high ratio of active vehicles per service vehicle, which greatly contributes to this business model's low GHG emissions per rider kilometre. This favourable ratio largely reflects less frequent maintenance events (assumed once every three months) in comparison with other shared services. It also results from lower frequencies of vandalism and damages since the vehicle is used by the same user for a significant amount of time.

Finally, leased bikes' favourable environmental performance stems from lower servicing requirements in comparison with shared bikes, as the leasing model does not require repositioning or battery swapping

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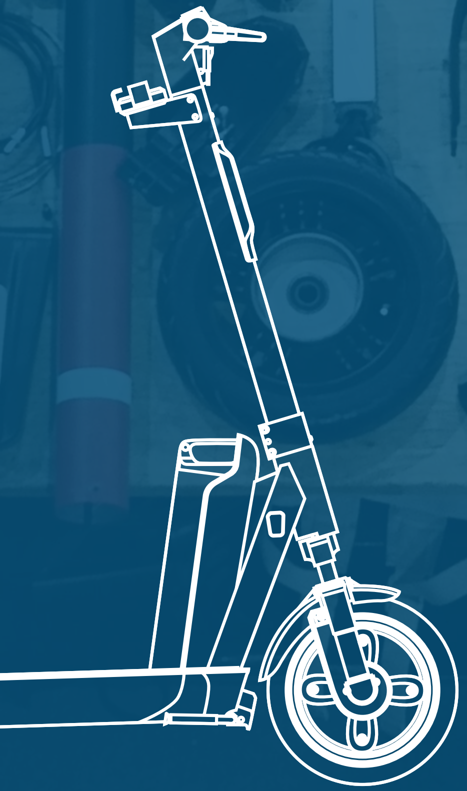
Improved micromobility vehicle design

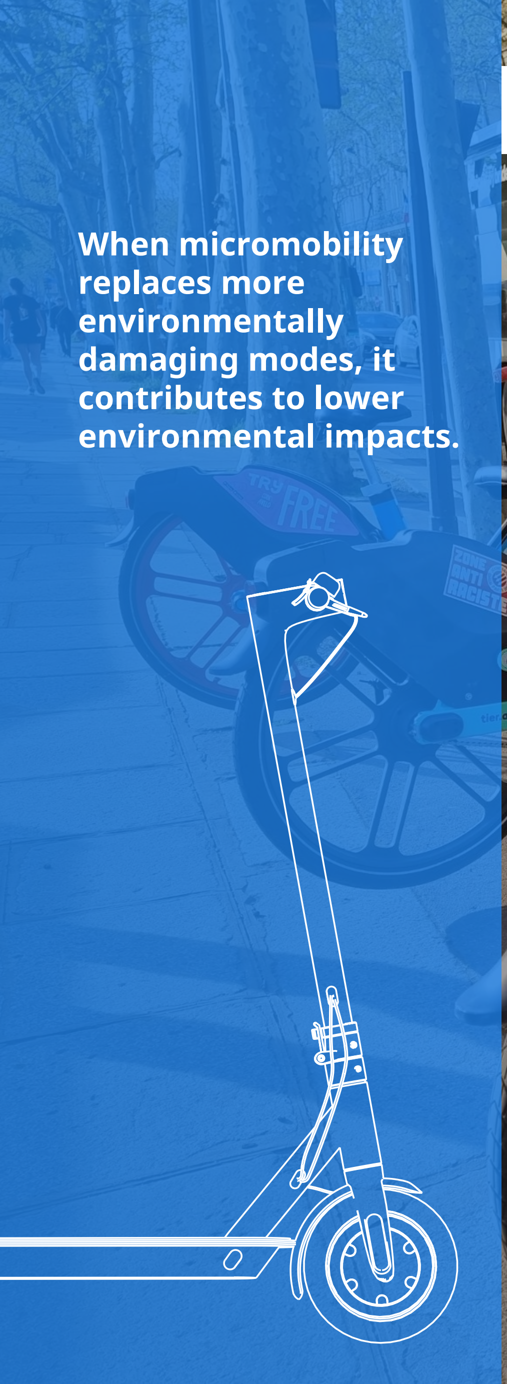
Vehicle design improvements greatly contribute to reducing environmental impacts and improving the economics of micromobility business models.



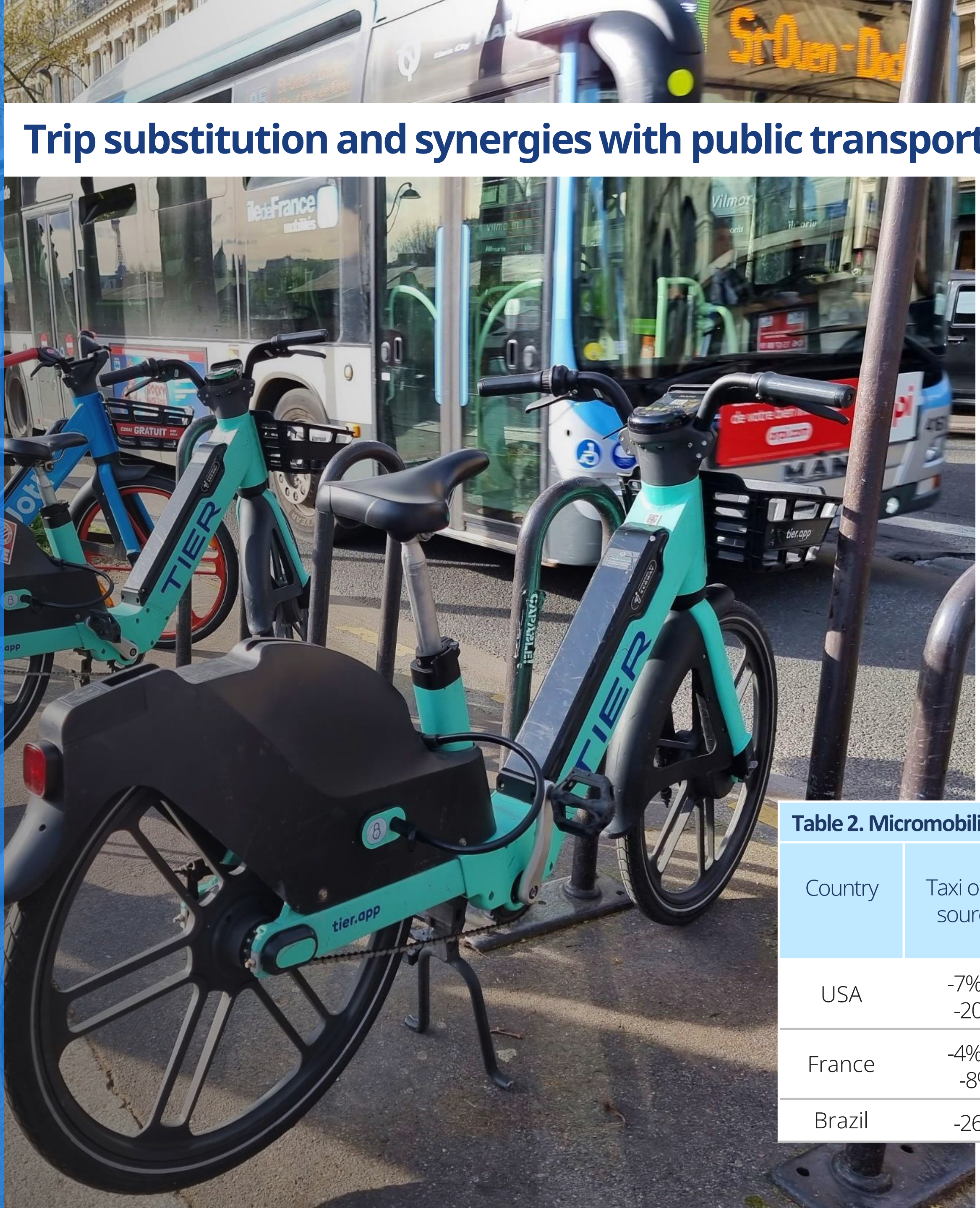
Micromobility vehicle design improvements have significantly reduced environmental impacts and improved the economics of micromobility business models. This is due to more modular and swappable component design, lower breakdown rates, better reparability, and longer component and vehicle lifespans. Overall weight gains have been minimal with respect to the then-latest generations of shared vehicles assessed in 2020, since many of the design changes outlined above were already integrated into those models. Design improvements continue to contribute to improved performance, although gains will likely slow over each successive vehicle generation.

Micromobility operator sustainability reports underscore the relevance of less energy and carbon-intensive material production and vehicle assembly processes. Operators' concerns over sustainability have expanded to economic circularity, as well as modularity and reparability by design across all business models, including e-scooter, bike or e-bike sharing, and bike or e-bike leasing. Several micromobility companies already report high shares of recycling for their end-of-life vehicles.

Reducing the lifecycle impacts from material use for micromobility will entail a systemic transition to increased circularity, beyond what can be achieved by the micromobility industry alone. The same holds true for lifecycle energy use. While commitments by individual industry players to source low-carbon electricity are welcome, the tasks of expanding renewable energy capacity and accelerating decarbonisation will require broader action across multiple economic sub-sectors.



Trip substitution and synergies with public transport



When micromobility replaces more environmentally damaging modes, it contributes to lower environmental impacts.

Micromobility's environmental impact depends on the environmental impact of the trips it replaces or generates (see Table 2). It is also linked to whether it promotes a less environmentally impactful lifestyle. Micromobility in car-dominated cities replaces more car travel than in other contexts. The substitution of walking trips is a concern from an environmental and health perspective in all contexts.

The ITF's 2020 assessment and other research highlights how micromobility can increase public transport catchment areas by serving as a feeder. Shared micromobility operator data suggest that between 40% and 63% of their riders connect with public transport services (Dott, 2023; Bolt, 2023; Voi, 2023).
Tier (2022) reports that more than half of its services are deeply integrated within Mobility as a Service (MaaS) platforms and that 23% of all its micromobility trips are multimodal.

These findings are consistent with observations made in the ITF's 2020 assessment. Where such data are increasingly collected by operators within their apps and in reference to specific trips, they are indicative of real trip contexts and behaviours in contrast to more general user surveys.

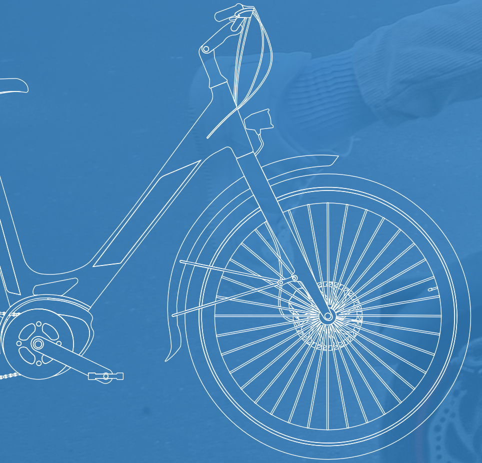
Table 2. Micromobility trip mode substitution effect

Country	Taxi or ride sourcing	Public transport	Cars	Walking	Other shared micro-mobility	New trips
USA	-7% to -20%	-3% to -18%	-10% to -20%	-30% to -60%	-2% to -10%	3% to 8%
France	-4% to -8%	-25 to 34%	-4% to -10%	-40% to -50%	-12%	3% to 6%
Brazil	-26%	-20%	-14%	-52%		

Source: ITF (2020), complemented by Krauss et al. (2022) and Wang et al (2022).

Local air pollution

Micromobility can reduce particulate matter and nitrous oxide pollution via cleaner fleet operations and replacing more polluting travel.



While this assessment focuses on the lifecycle GHG emissions of different forms of micromobility, other environmental impacts are also worth addressing – particularly local air pollutants, including fine particulate matter (PM) from engine combustion and brake pad and tyre wear, as well as nitrous oxides (NO_x). The lifecycle GHG reductions documented in this study will likely be accompanied by a reduction in those pollutants due to the following reasons:

- Micromobility vehicles emit zero local pollutants (or very close to zero) due to their low weight and minimal tyre wear, adding to their very low contribution to fine particle resuspension due to their minimal frontal surface dimensions.
- Electrified servicing vehicle fleets reduce NO_x and PM emissions from combustion.
- The reduction in servicing vehicle travel per active micromobility vehicle travel alongside the deployment of lighter cargo bikes contributes to lower PM from servicing vehicle brake pad and tyre wear.
- Longer vehicle lifespans lead to lower raw material and related energy intensity per active micromobility vehicle travel.
- Local pollutant emissions are reduced in those contexts where micromobility replaces trips by more polluting modes or heavier electrically powered modes such as electric cars.

Recommendations for public authorities

Require transparent environmental impact reporting

Public authorities can condition licensing or concessioning of micromobility services based on environmental impact. Such obligations should be at least as stringent as for other licensed or concessioned services. Given micromobility services' generally low environmental impact compared to other modes, these conditions should not be more stringent than for other modes unless the reporting and transparency requirements for other modes are also tightened.

Foster trust in and comparability of impact assessments

Encourage the use of comparable, transparent and best practice lifecycle environmental impact assessment methodologies. Using trusted third-party verification ensures operator impact assessments are comparable and help establish a level playing field for genuine competition.

Support impact-based outcomes for micromobility

Authorities could consider the use of conditional incentives – including micro-subsidies (Schlebusch, 2023) or dis-incentives for operators, based on environmental impact indicators based on standardised data.

Provide adequate parking for micromobility

Adequate provision of parking for micromobility increases its attractiveness over car use and contributes to lower environmental impacts. Authorities should provide micromobility parking both for individually owned micromobility and shared services.

Ensure minimum environmental performance standards

Micromobility vehicle homologation or self-certification regimes for both private or shared vehicles should address the minimum desired environmental requirements for vehicles and their batteries, including end-of-life management.

Leverage existing approaches to deliver better outcomes for cities

Consider the use of public service contracts to support the deployment of micromobility services in conjunction with public transport in targeted areas. These approaches could develop and integrate mechanisms enabling access to public funding based on minimum performance requirements.

Reinforce synergies between micromobility and public transport

Enhance the connectivity and co-ordination of micromobility uses and services with public transport to create synergies that lead to increased use of both modes – especially over longer distances. Providing or incentivising adequate parking at or near public transport hubs is crucial.

Facilitate the integration of micromobility services into Mobility as a Service

Including shared micromobility services into Mobility as a Service offerings helps integrate public transport and micromobility and increases awareness of available micromobility options.

Reinforce meaningful data collection about micromobility and its impacts

Collect statistics on micromobility travel activity, related energy use, differentiating across different categories and types of services, and integrate micromobility options in travel surveys. Work with operators to achieve standardised data collection wherever possible.

Recommendations for micromobility industry and operators

Continue efforts to reduce the environmental impact of micromobility

Rapid environmental gains have been achieved by industry actors who extend vehicle and component lifespans, design for modularity and reparability, improve fleet operations and electrify service vehicles. These efforts should be pursued and documented.

Monitor the lifecycle environmental impact of fleet operations

Integrating lifecycle carbon and energy intensity in decision-making processes regarding the sourcing of materials and energy needed to service and operate fleets also contributes to better environmental performance.

Establish transparent and comparable metrics to track environmental performance

Establish verifiable and transparent procedures to collect data, elaborate performance indicators, leveraging – where appropriate – the availability of standard lifecycle assessment methodologies. Document these and make them publicly available.

Align data collection approaches with public authorities and other stakeholders

The development and uptake of common data collection frameworks – including standardised specifications such as the Mobility Data Specification (MDS). Paired with the adoption of common reporting outputs across all stakeholders, this facilitates data reporting and tracking of environmental performance.

Set environmental performance targets and document progress towards meeting them

Leverage data collection to set environmental performance targets and report on progress towards meeting these targets, linking, where appropriate, with improved business outcomes.

Engage with authorities and public transport operators to improve synergies with public transport

Engage proactively with public authorities and public transport operators to improve micromobility connections to public transport to enhance the attractiveness of both services – particularly in lower-density urban areas and suburbs.

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Colophon

Disclaimer

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About the International Transport Forum

Who we are

The International Transport Forum at the OECD is an intergovernmental organisation with 69 member countries. It acts as a think tank for transport policy and organises the Annual Summit of transport ministers. The ITF is the only global body that covers all transport modes. It is administratively integrated with the OECD, yet politically autonomous.

What we do

The ITF works for transport policies that improve peoples' lives. Our mission is to foster a deeper understanding of the role of transport in economic growth, environmental sustainability and social inclusion and to raise the public profile of transport policy.

How we do it

The ITF organises global dialogue for better transport. We act as a platform for discussion and pre-negotiation of policy issues across all transport modes. We analyse trends, share knowledge and promote exchange among transport decision-makers and civil society. The ITF's Annual Summit is the world's largest gathering of transport ministers and the leading global platform for dialogue on transport policy.

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The Corporate Partnership Board (CPB) is the ITF's platform for engaging with the private sector and enriching global transport policy discussion with a business perspective. The members of the ITF Corporate Partnership Board are: Airbus, Allianz Partners, Alstom, Amazon, Aramco, AutoCrypt, Bolt, Bosch, BP, CEIIA, Cruise, DP World, Enel, ExxonMobil, FS Italiane, Honda, Hyundai Motor Company, Iberdrola, Kakao Mobility, Michelin, Microsoft, Mott Macdonald, NXP, PTV Group, RATP Group, Rolls Royce, Shell, Siemens, TotalEnergies, Toyota, Trucknet, Uber, Valeo and Volvo Group.

About this report

In 2020, the ITF published “Good to Go? Assessing the Environmental Performance of New Mobility”. In the four years since its publication, the evidence base on the environmental impact of micromobility has improved.

This report updates the previous study based on newly published evidence, a survey of industry actors, and recently published reports.

The report provides recommendations for authorities and micromobility operators to maximise the environmental performance of micromobility.

It draws on a comprehensive lifecycle environmental impact spreadsheet tool made available on the ITF website. This tool contains all calculations, input factors and sources used for this update.

Link to the spreadsheet tool

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