Do shared e-scooters and e-bikes reduce the emissions of urban transportation systems?

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The use of shared micromobility services has increased in recent years, particularly in urban areas. But can shared e-scooters and e-bikes contribute to the sustainability of cities and their transportation systems?

To answer these and other questions, Fraunhofer ISI conducted a new study on behalf of the micromobility provider Lime by fusing mode shift survey data with lifecycle emissions data in six cities around the world. The study also sets out what implications these findings have for industry and practice.

Most recently, the CO_2 emissions in the global mobility and transport sector have increased by 8% in 2021, even though they are supposed to decrease by 20% until 2030 to meet international climate targets. To achieve these extremely challenging goals, a broad range of measures are necessary, including a rapid electrification of road vehicles, an expansion of public transport and better networking of various modes in transport systems. New forms of shared micromobility have emerged over the past decade, especially in urban areas, complementing existing mobility offers with the promise to reduce urban transport's carbon footprint.

However, it is currently heavily debated whether and, if so, to what extent shared e-scooters and e-bikes actually contribute to the goal of reducing CO_2 emissions. Previous studies have primarily focused either on comparing single modes of transport through life cycle assessments (LCA) or on who uses these new modes for which purposes. Research on the overall consequences of micromobility usage for respective emissions of the transportation system, however, is limited.

To increase the knowledge about the effects, Fraunhofer ISI has conducted a new study that aims to present a snapshot of case studies in six cities around the globe (Berlin, Dusseldorf, Paris, Stockholm, Melbourne and Seattle) and collects data of shared micromobility users with a total sample size of 4,167 individuals. The data was provided by the shared micromobility provider Lime. To calculate the emission impact of the individuals' behavior, existing LCA data was combined with LCA estimates for latest generation shared Lime e-scooters and e-bikes by Anthesis on behalf of Lime, and both were adjusted to the characteristics of the cities in question.

Shared e-scooters and e-bikes can help to reduce carbon emissions

The study's findings show that the latest generation of shared e-scooters and e-bikes can reduce net carbon emissions. These are defined as the differences between the life cycle assessment emissions per passenger kilometer (pkm) of the shared micromobility mode and the modes people would have used if shared e-scooters or e-bikes would not have been available.

This analysis was carried out for transportation systems in the six surveyed cities: The largest effects for shared e-scooters are observed in Melbourne (-42.4 g/pkm) and Seattle (-37.7 g/pkm) which can be explained by a considerably higher CO_2 intensity of electricity used for public transport and electric cars compared to the European cities. But also Dusseldorf (-22.1 g/pkm), Paris and Stockholm (-20.7 g/pkm) show effects of reduced emissions while e-scooters in Berlin show smaller reductions (-14.8 g/pkm). In all cities, the net carbon impact of shared e-bikes is less beneficial than shared e-scooters. Large emission reductions are estimated for Dusseldorf (-20.4 g/pkm), Paris (-15.4 g/pkm), Seattle (-15.2 g/pkm), and Melbourne (-13.7 g/pkm), while the estimated emissions for Berlin increase (+13.0 g/pkm).

This can be explained due to smaller shares of shared e-bike trips replacing individual motorized modes, slightly higher theft rates, and by their lower usage intensity compared to shared e-scooters.

A deeper analysis at the transportation mode level helps to further explain the effects observed at the city scale for all locally available Lime services. For this task the study estimated total emissions by upscaling the survey assessment with usage patterns for the study period

(May and June 2022) provided by Lime. In fact, the largest differences in net emissions by replaced modes originate from ridehailing or taxi services (-679.3 and -541.0 g CO_2 equivalents per trip for shared e-bikes and e-scooters respectively) and personal combustion cars (-334.6 and -272.9 g). When shifting from these highly emitting modes to shared micromobility, the net emissions reduction is quite substantial.

On the other hand, shared micromobility can also lead to increasing emissions when for example personal e-bike usage (+126.3 and +18.8 g) and walking (+109.9 and +39.4 g) is replaced by using a shared e-scooter or shared e-bike, or when a trip that would not have taken place before is now undertaken with a shared e-scooter or e-bike (+65.6 and 199.3 g). However, the increase in emissions tend to be smaller than the reduced emissions of the previous mode shifts.

Konstantin Krauss, mobility researcher at Fraunhofer ISI and co-author of the study, states, "Our results show that the crucial factor for the net impacts of shared micromobility is the number of trips replacing the highest-emitting transportation modes such as ride-hailing and trips with combustion cars in comparison to induced, active mode, and public transport trips. For all results, however, we need to consider uncertainty in the stated—not observed—responses of the participants and a range of uncertainties of +/-25% in LCA numbers: The applied LCA numbers are estimates also based on assumptions for factors such as vehicle lifetimes or operations. For the responses of the riders, we use stated preferences of the respondents only, so we did not observe their real mode shift behavior. Moreover, the question of how the currently progressing electrification of car, bus, taxi and ride-hailing fleets will decrease the impact of micromobility to net climate impacts remains open."

Recommendations for industry, micromobility providers and city planners

But what can be done to further enhance the sustainability benefits of shared micromobility? Dr. Claus Doll, Fraunhofer ISI mobility expert and co-author of the study, has the following recommendations for industry, micromobility providers and city planners: "On the one hand industry should further extend vehicle lifespans, continue to decarbonize manufacturing by contributing to a circular economy, and use partnerships to induce favorable mode shift from taxi, ride-hailing and personal cars. And on the other hand, providers and city planners should jointly work towards a better connection of micromobility and public transport by for instance establishing mobility hubs and reliable intermodal travel planning tools for seamless transfers." He adds that the shift effects from public transport and walking to shared micromobility should be kept at a minimum.

Andrew Savage, vice president for sustainability at Lime, underlines the strides Lime and the industry have made in decarbonizing their service over a short timespan: "The examples of the six cities show that shared e-scooters and shared e-bikes can help to make cities more sustainable and livable by reducing emissions and expanding the mobility offer. The findings underscore the important work we must continue to decarbonize our supply chain, operations and facilities so that shared micromobility will continue to reduce the carbon footprint of urban mobility."

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