

ANALYSIS

Voi E-Scooter Lifespan

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Replacing short car trips with shared micromobility can go a long way toward helping cities to achieve their goals of reducing carbon emissions and urban congestion. For example, according to a study by Carbone 4, approximately 21% of all trips in Paris could be taken on micromobility, supporting a reduction of emissions from energy consumption of 68%.¹ And according to data collected through Voi user surveys, between 20-39% of e-scooter trips in Europe are replacing car trips.

Despite this promise, some city officials question the sustainability of shared e-scooters due to concerns over a short vehicle lifespan. Extending vehicle lifespan is key to ensuring micromobility is sustainable from a lifecycle perspective. Further, understanding fleet average lifespan and the factors that contribute to premature e-scooter retirement is necessary to support more durable vehicle design and improved micromobility operations.

Electric Avenue was commissioned by Swedish micromobility company Voi to conduct an independent analysis of the company's data to determine fleet average lifespan, analyze how this figure impacts the overall environmental footprint, and make recommendations for further improvement. This document summarizes our findings.

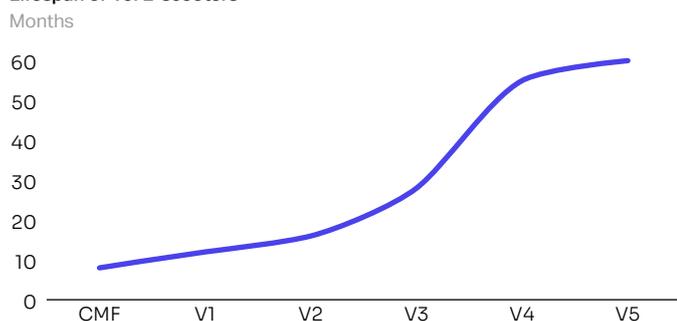
Developing a new methodology

We analyzed two years of real-world e-scooter fleet data provided by Voi's operations team. The data tracks e-scooters by vehicle identification number and covers two generations: the Voyager 3X (V3X), launched in 2019, and the Voyager 4 (V4), which launched in 2021. This data set notes e-scooter status, including active (still in the fleet), lost (theft or unknown missing), decommissioned (retired due to damage or other reason), or sold (sold to a private owner or third-party operator).

The data set for Voi's batteries was similar to that of e-scooter frames, though not as detailed. This data set tracks batteries as cohorts, rather than via individual identification number, and only included data for one year, somewhat limiting the rigor of analysis we were able to conduct for batteries.

We used the data to develop a model that projects the expected lifespan based on empirical rates of loss and decommissioning. The fleet average lifespan was determined to be the point at which 50 percent of vehicles were lost or decommissioned. The model also allowed us to explore patterns in vehicle retirement across generations and across cities.

Lifespan of Voi E-scooters



The V4 scooter is projected to last 4.6 years, almost 5x longer than Voi's first-generation e-scooter

As detailed above, **we estimate that the lifespan of the V4 is 4.6 years (7,600 km) for the frame and 3.7 years (116.7 kWh) for the battery.** Based on estimates from Voi staff, consumer model e-scooters (CMF) launched in early 2019 and lasted about six months in a shared environment, while Voi's first custom vehicle (V1) lasted around one year. As shown in the graphic below, lifespan has improved significantly since then, with today's e-scooters expected to last almost 5x longer than the V1. The lengthening of lifespan has been achieved through the following approaches.

Vehicles designed for use are more durable than early generations. In the company's early days, Voi used the Ninebot CMF, an off-the-shelf model with a narrow neck, small wheels, limited weatherization, and exposed wires and screws. Today, Voi's vehicles are customized for shared use: the neck is 50 percent wider, wheels are 30 percent larger, and the vehicles have no exposed wires or screws.



Modular parts have made e-scooters easy and inexpensive to repair. While replacement parts for early consumer models were sometimes hard to come by, Voi now stocks spare parts in-market. Having spare parts on hand streamlines the repair process, decreasing the need to replace damaged vehicles with entirely new ones.



Battery management systems have helped to optimize charging and maintenance practices for batteries. Voi has invested in a battery management system and partnered with Nortal, a third-party battery analytics company, to collect data on battery performance and reshape its battery management practices. For example, the company has adopted a protocol to recharge batteries before they reach 20 percent, rather than let them drain fully.



Diagnostics and automated alerts have supported proactive maintenance. Voi has added sensors on vehicles and incorporated algorithms into its maintenance software, which alert the team when a part is functioning abnormally or when a vehicle is due for an inspection. This practice appears to have reduced the severity of vehicle maintenance needs.



Programs to limit theft and vandalism appear to have been effective. Voi has decreased theft and vandalism through tamper-resistant design, improved fleet management, and improvements in GPS tracking, which allows lost or stolen vehicles to be located more easily. According to Voi's data, this has reduced lost vehicles by 85 percent since 2019.



Resale programs to have extended vehicle life. Voi launched its resale program in April 2020 to give vehicles retired from its own fleet a "second life." Roughly 50 percent of vehicles sold have gone to private use, and 50 percent to third-party operators, extending their life beyond Voi's fleet.



¹ Carbone4. *The Role of E-e-scooters and LEVs in Decarbonizing Mobility*. 2019.

Opportunities to further extend Voi's e-scooter lifespan

Shared e-scooter programs have grown quickly, expanding from just a few cities in 2018 to more than 500 cities today. The e-scooters in Voi's fleet today are notably sturdier than their predecessors, and the company's technology and operating practices have matured significantly. This progress has extended the average lifespan of the company's e-scooters by almost 5x, reducing environmental impacts and growing the sustainability benefits offered to cities.

Given this trajectory, but keeping in mind limitations in the form factor, we expect the lifespan of the V5 to be longer than the V4, as shown in the table below.

However, additional improvements in Voi's data collection protocols are necessary if the company wants to continue to improve its sustainability performance. In particular, more detailed tracking of its batteries would provide a more accurate estimate of lifespan and help the company to identify opportunities to extend useful life, develop a refurbishing practice, and improve second-life programs.



	2018	2019	2020	2021	2022
Launch year	2018	2019	2020	2021	2022
Vehicle lifespan	8 months 	16 months 	28 months 	55 months 	60 months ²
Features	Consumer grade e-scooter	Partially customised e-scooter Improved suspension	Fully customised for sharing Swappable batteries Tamper proof design updates	Modular parts Improved GPS precision Improved weatherisation 50% wider neck	Design and repairability improvements 12" wheels

About the Authors and Advisors

Melinda Hanson

Principal at Electric Avenue

Melinda is co-founder of Electric Avenue, a Brooklyn-based consulting firm specializing in light electric transport. She was previously Head of Sustainability at Bird, the California-based shared electric e-scooter company.

Chris Cherry

Professor at the University of Tennessee

Chris is a professor in Civil and Environmental Engineering at the University of Tennessee and an internationally recognized expert in electric micromobility and sustainable transport.

Matt Chester

Affiliate at Electric Avenue

Matt is a data analyst with expertise in energy policy, transportation technology, and sustainability.

Pierpaolo Cazzola

Independent Consultant

Pierpaolo is a transport researcher and lifecycle assessment expert who led the seminal report "Good to Go? Assessing the Environmental Performance of New Mobility" for the OECD's International Transport Forum.

² V5 lifespan is a forecast based on design improvements