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Dynamic LCA of Electric Vehicles Use Phase: A Python-Based Approach Using Real-World Data

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Objective: This study evaluates the real-world environmental impact of electric vehicle (EV) usage in Italy, with a specific focus on the city of Florence. It aims to address existing gaps in Life Cycle Assessment (LCA) studies of the use phase, which often neglect dynamic conditions such as temperature variability, electricity grid mix composition, and traffic conditions.
Methodology: A computational LCA method is applied, using Python-based modelling and real-time data integration via APIs. This approach allows for a more precise evaluation of EV environmental performance by considering dynamic elements that affect energy use and emissions.
Results: The findings highlight significant variations in environmental impact depending on real-world conditions. Traffic congestion, lower temperatures, and a carbon-intensive electricity grid contribute to increased emissions and reduced efficiency, while battery
degradation further affects overall performance. Additionally, this study introduces an innovative methodology that integrates LCA with real-world dynamic data through a computational tool, improving the reliability of environmental impact assessments.
Conclusion: This work serves as the basis for a more holistic investigation of EV use- phase effects, considering real-world dynamics. It also opens possibilities for future research, like Vehicle-to-Grid applications, where flexible consumers can support the grid and, if properly optimized, contribute to reducing overall environmental impact. The insights provided may help inform and enhance the development of more sustainable mobility and energy policies for policymakers and stakeholders.

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