The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of Michael Samsu Koroma

The public defense will take place on Wednesday 29th May 2024 at 5:00 pm

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IMPROVING THE ENVIRONMENTAL PERFORMANCE OF PASSENGER ELECTRIC CARS: A LIFE CYCLE SYSTEM APPROACH

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Abstract of the PhD research

Environmental pressures like global warming, air pollution, resource depletion, and biodiversity loss pose significant threats to human well-being. Human activities contribute heavily to these issues, necessitating urgent reductions in greenhouse gas (GHG) emissions across all sectors. Electric vehicles (EVs) offer a promising solution by reducing fossil fuel reliance and eliminating harmful tailpipe emissions. However, the shift to EVs introduces challenges, such as continued reliance on fossil fuels for electricity generation and the environmental impacts of manufacturing advanced powertrain components. These challenges underscore the importance of understanding the life cycle environmental performance of EVs.

The life cycle environmental performance of EVs can be assessed using Life Cycle Assessment (LCA). LCA is a holistic tool that assess environmental problems of products considering their life cycle stages from raw material extraction to end-of-life disposal. In that light, this PhD thesis investigates the environmental impacts of current and future battery electric vehicles (BEVs) through Life Cycle Assessments (LCA). The study highlights that BEVs can significantly reduce GHG emissions compared to internal combustion engine vehicles (ICEVs), but their performance is influenced by factors such as the source of charging electricity, battery efficiency, and drivetrain effectiveness.

A novel strategy was developed to assess BEVs’ environmental performance by integrating future changes in vehicle production, charging electricity mixes, battery efficiency fades, battery refurbishment, and recycling. This innovative approach, applied for the first time, indicates that future BEVs in a low-carbon EU scenario could reduce global warming impacts by 66-75%, primarily due to renewable energy adoption and hydrogen-based iron production.

The thesis also evaluates current BEVs, showing a 9.4% reduction in global warming impacts with increased renewable energy in the charging mix and additional reductions through recycling and battery refurbishment. However, battery efficiency fades can increase use-stage impacts by 7.4-8.1%.

Under the European FITGEN project, the environmental performance of a new e-axle powertrain was assessed. The results revealed a 10% reduction in global warming impacts and a 17% decrease in energy consumption compared to the 2018 state-of-the-art e-drive.

Overall, the thesis underscores the importance of considering future energy sources, material production innovations, battery efficiency, refurbishment, and recycling in BEV assessments. It provides insights for policymakers and manufacturers to align vehicle electrification with renewable energy integration and optimise the entire supply chain, emphasizing early implementation of energy efficiency measures. The study recommends improving component efficiency, reducing electronics use, and adopting a holistic LCA approach that accounts for temporal aspects in the production and use stages.