cbecimat26
26° Congresso Brasileiro de Engenharia e Ciência dos Materiais
22 a 26 de novembro de 2026
Costão do Santinho
Florianópolis-SC

Life Cycle Assessment of Material Requirements in Internal Combustion and Electric Vehicles

Sarah M. Pasini[1]; Ana Lucia de S. Niero[1]; Sergio Y. G. Gonzalez[1], Dachamir Hotza[1]

[1]Federal University of Santa Catarina, 88040-900 Florianopolis, Brazil

Introduction

The rapid adoption of electric vehicles is reshaping material demand, particularly for batteries and powertrains. Although battery electric vehicles (BEVs) eliminate tailpipe emissions, their production may involve substantial environmental burdens. Life cycle assessment (LCA) enables comparison with internal combustion engine vehicles (ICEVs), helping identify environmental hotspots and opportunities for more sustainable material production.

Objective

To compare the cradle-to-gate environmental impacts of selected BEV and ICEV components, focusing on greenhouse gas emissions, energy demand, and total water use.

Methodology

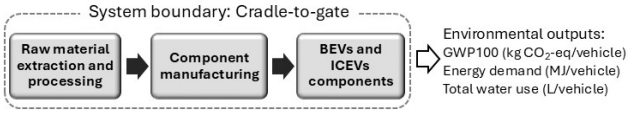

Figure 1. *Cradle-to-gate system boundaries adopted.*

A comparative LCA was conducted using the GREET model developed by Argonne National Laboratory, considering 2024 vehicle configurations. Component masses were combined with process-specific environmental factors to estimate cradle-to-gate impacts. Three indicators were assessed: GWP_{100} (kg CO_2-eq), total energy demand (MJ), and total water use (L).

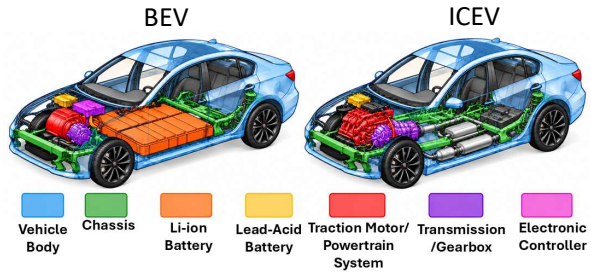

Figure 2. *Schematic representation of the BEV and ICEV components included in the assessment.*

Results and Discussion

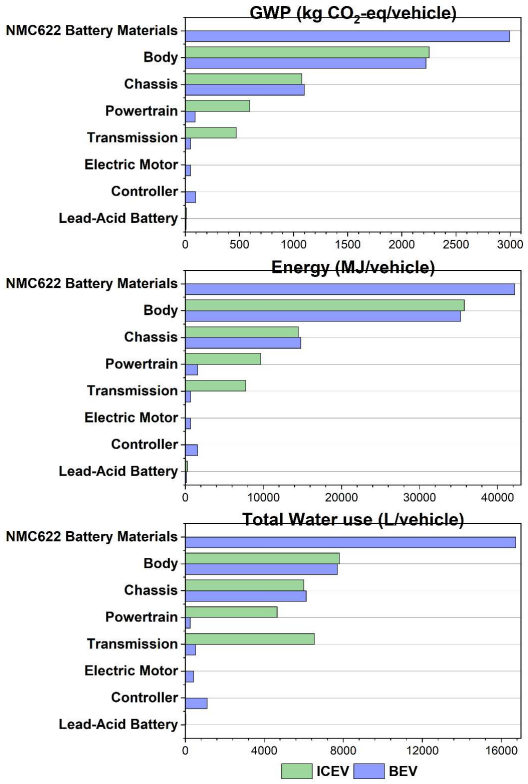

Figure 3. *Cradle-to-gate environmental impacts of BEV and ICEV components.*

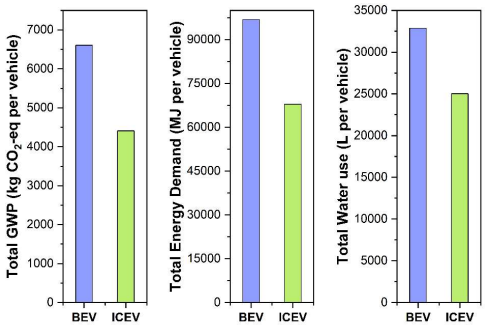

Figure 4. *Comparison of total cradle-to-gate environmental impacts of the assessed BEV and ICEV components.*

Conclusion

BEV components exhibited higher cradle-to-gate impacts across all three indicators, primarily driven by NMC622 battery materials. In contrast, ICEV impacts were more distributed among structural and powertrain components.

References and Acknowledgments

[1] Argonne National Laboratory. *R&D GREET Model*. https://greet.anl.gov/
[2] IEA. *Global EV Outlook 2024*. International Energy Agency, Paris, 2024. https://www.iea.org/reports/global-ev-outlook-2024
[3] Hawkins, T. R. et al. Comparative environmental life cycle assessment of conventional and electric vehicles. *Journal of Industrial Ecology*, 17, 53–64, 2013. https://doi.org/10.1111/j.1530-9290.2012.00532.x
[4] Ellingsen, L. A.-W. et al. Life cycle assessment of a lithium-ion battery vehicle pack. *Journal of Industrial Ecology*, 18, 113–124, 2014. https://doi.org/10.1111/jiec.12072

fapesc CNPq Finep CAPES LINDEN UFSC