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*A comprehensive review of hybrid electric vehicles,
technological advancements, and overcoming challenges*

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Abstract:

Hybrid Electric Vehicles have emerged as a promising solution to address the pressing issues of environmental sustainability and energy efficiency in the automotive industry. This paper presents a comprehensive review of the latest advancements in HEV technology, focusing on key innovations and breakthroughs that have shaped the landscape of sustainable transportation. Beginning with an overview of the fundamental principles of HEVs, including powertrain architectures and energy management systems, the paper explores recent developments in battery technology, electric motor design, and control strategies. Furthermore, this review highlights the challenges and barriers hindering the widespread adoption of HEVs, such as cost, infrastructure, and consumer acceptance. Additionally, the paper examines emerging trends in HEV design, such as plug-in hybrid systems and vehicle-to-grid integration, which have the potential to further enhance the efficiency and environmental impact of HEVs.

Index Terms-Hybrid Electric Vehicles (HEVs), Plug-in Hybrid Electric Vehicles (PHEVs), carbon dioxide (CO₂)