

Environmental Science and Engineering

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Towards Sustainable Geographies with Net Zero Carbon Economy

The 12th International Conference
on Energy and Environment Research
(ICEER 2025)

 Springer

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Lithium Role in the Clean Energy Transition: Challenges and Prospects

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Abstract. Global decarbonization strategies depend on the large-scale electrification of the transport sector, mainly supported by lithium-ion battery technologies. Lithium's role in assisting low-carbon mobility has driven a fast rise in demand. This has intensified concerns regarding resource scarcity and supply chain vulnerabilities, particularly in the European Union, which remains heavily dependent on imports. The restricted availability of lithium and other critical raw materials, compounded by geopolitical tensions, poses a risk to the resilience of the clean energy transition. In this sense, the adoption of circular economy principles has emerged, emphasizing material recovery, recycling, and resource efficiency. This review provides a comprehensive analysis of lithium relevance in the energy transition, with a focus on resource trends, recovery technologies, and battery production. A systematic understanding of these trends and challenges is needed to guide future developments and ensure a secure, sustainable, and circular lithium value chain that supports the transition to clean energy systems.

Keywords: Battery · Critical raw material · Decarbonization · Metallurgical treatment · Vehicle electrification

1 Introduction

The clean energy transition is reshaping global paradigms related to the production and consumption of raw materials [1]. With the global population projected to keep growing over the next 50–60 years, reaching a peak of approximately 10.3 billion by the 2080s, resource demand is expected to increase substantially [2]. However, unrestricted access to certain raw materials is posing risks to sustainable progress [3].

The transport sector alone is responsible for more than one-third of carbon dioxide (CO₂) emissions from end-use sectors [4]. To reverse this trend, one of the primary solutions is the electrification of vehicles [5]. Achieving alignment with the “Net Zero Emissions by 2050” scenario needs the implementation of comprehensive policies. These include modal shifts toward low-carbon transportation options and adopting operational and technical efficiency measures to reduce the carbon intensity of transport modes.