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Session 6B: Circular Economy II

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Evaluating the Environmental Impacts of High-Efficiency Electric Motors: A Comparative Analysis of SCIM, SynRM, and PMSM Technologies

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ABSTRACT. Enhancing electric motor efficiency plays a pivotal role in addressing climate change in industrial applications. Prior studies pre-dominantly emphasized efficiency during the operational lifecycle, neglecting the environmental ramifications of their production and maintenance. By July 2023, European regulations mandated that motors with a capacity ranging from 75 to 200 kW adhere to IE4 efficiency standards, while motors under 75 kW, specifically those utilizing Squirrel Cage Induction Motors (SCIMs), comply with IE3 standards. The pinnacle of efficiency, IE5, is obtained through Synchronous Reluctance Motors (SynRM) and Permanent Magnet Synchronous Motors (PMSM). This research delves into these motor technologies' environmental life cycle impacts, contrasting the environmental footprint of SCIMs at IE3 against that of SynRM and PMSM at IE5. Utilizing the EuP Eco-Report tool as part of the Methodology for the Ecodesign of Energy-related Products (MEErP), this analysis focuses on the life cycle impacts of 11 kW motors featuring a 4-pole design. Findings indicate that while IE5 SynRMs exhibit superior operational efficiency, their production phase incurs greater environmental impacts due to the materials required. PMSMs, although highly efficient, present substantial environmental challenges, particularly in their production, attributed to the mining of rare earth elements