Title: Potential for Reducing Greenhouse Gas Emissions through Eco-Design of Elevators

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Satoshi Ihara[1, *], Akihiro Yamaguchi[1], Takashi Abe[2]
[1] Research and Development Group, Hitachi, Ltd., Japan
[2] Hitachi Building Systems Co., Ltd., Japan

E-mail: satoshi.ihara.sf@hitachi.com, Phone number: +81-80-2686-7889

Abstract: As global urbanization accelerates, it is projected that 68% of the world's population will live in cities by 2050, leading to more high-rise buildings and a growing environmental impact from elevators. The IPCC Sixth Assessment Report emphasizes the need to reduce global greenhouse gas (GHG) emissions by 43% by 2030 and 60% by 2035. A circular economy strategy and GHG reduction for elevators is essential to meet these targets. Currently, most GHG emissions from elevators are generated during production and operation, with the industry primarily focusing on reducing operational emissions. However, eco-design and GHG reduction in production are necessary. This study examines the potential for reducing GHG emissions from elevators through the eco-design of materials, evaluated using life cycle assessment (LCA). As a representative example, a 9-person machine room-less elevator for apartment buildings was evaluated. The LCA results demonstrated that the primary source of emissions during the production stage is the steel components, including the car structure and the rail within the hoist way. To examine future emission trends, scenarios for the power emission factor in 2030 and 2035 were initially set up. Based on these scenarios, emissions during the production stage of the elevator were projected when the steel materials used are blast furnace iron produced from iron ore as the raw material. Subsequently, emissions in 2030 and 2035 were evaluated for several scenarios in which steel materials are composed of a mixture of blast furnace iron, electric arc furnace (EAF) iron produced by electro-refining of iron scrap, and hydrogen direct reduction iron (H2-DRI) produced by direct reduction of iron ore with hydrogen. Furthermore, scenarios were established in which partial reuse of steel components was implemented in addition to the types of steel materials mentioned above, and emissions were evaluated accordingly. These studies indicate that while the utilization of EAF iron and H2-DRI is effective in achieving the 2030 reduction target, it falls short of achieving the 2035 target. However, the scenario of reusing steel components, in addition to the aforementioned factors, gives a reasonable prospect of meeting the 2035 target. The results indicate that combining the use of low-emission materials with the reuse of parts based on a circular economy is a fundamental strategy for eco-design in the production stage of elevators. Implementing this in conjunction with existing measures such as energy conservation will make a significant contribution to preventing global warming associated with urbanization.