The Decarbonization Journey of the Aluminium Industry – Opportunities and Challenges to Achieve Net-Zero

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Abstract

The aluminium industry plays a critical role in the decarbonization of many sectors of society, but it is also a significant contributor to global greenhouse gas emissions. The challenge for the industry is to continue enabling positive developments while minimising negative environmental impacts. The production process for aluminium generates three primary sources of GHG emissions: CO_2 emissions from electricity production for the electrolysis process (65 %), direct emissions from the smelting process (12 %), and fuel consumption for calcination, melting, and heating purposes (23%). However, decarbonization of the entire supply chain through renewable energies, biomaterials, inert anodes, carbon capture and storage (CCS) etc., is possible. The paper provides a high-level overview of the steps, costs, and necessary policies to transform the aluminium industry to become carbon-neutral and achieve Net-Zero solutions. Furthermore, aluminium has the potential as an energy carrier due to its energy density, transport safety and economics, and storage capacity. The industry can contribute to the fight against climate change and help decarbonize society by providing massive amounts of aluminium required for Net-Zero emissions in transport, energy generation/storage/distribution, building, and packaging. Aluminium is the third most abundant element in the earth's crust, and its exploration is less abrasive to the environment than the extraction of alternative metals (e.g. copper). Aluminium smelters can help to transport renewable energy via aluminium instead of hydrogen, making it relevant for new greenfield smelters or regions with potential surplus renewable energies. The paper also highlights the low-carbon aluminium trends and industry targets, such as establishing a green premium for low-carbon aluminium products. However, accounting loopholes and relabelling of renewable electricity may hinder the creation of a substantial low-carbon aluminium premium early in the cycle.

Keywords: Net-Zero, Variable renewable energy (VRE), Carbon capture and storage (CCS), Hydrogen, Energy carrier.