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RESEARCH REPORT

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Bartlomiej Kolodziejczyk, PhD

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About the Editor

Bart Kolodziejczyk, PhD, is the Chief Scientist of Australian mining company Fortescue Metals Group Ltd. Previously, Dr. Kolodziejczyk served as the Technology Officer of Singapore-based H2SG Energy Pte Ltd. In his hydrogen-related roles, Dr. Kolodziejczyk developed hydrogen generation technologies and worked with numerous customers throughout the Asia-Pacific region to implement hydrogen solutions in transportation, energy storage, and other industrial applications. He became interested in hydrogen power in 2009 while developing and testing solar and fuel cell inverters for Danfoss Solar Inverters A/S.

Dr. Kolodziejczyk holds a master's degree in Renewable Energy Science with a focus on Fuel Cell Systems and Hydrogen awarded jointly by the University of Iceland and the University of Akureyri, as well as two PhDs in Materials Engineering from Monash University in Australia and Microelectronics from École des Mines de Saint-Étienne in France. He has extensive research experience in electrochemistry, catalysis, fuel cell development, and hydrogen generation. He was a Research Fellow at Carnegie Mellon University, where he explored materials for biosensing and energy applications.

Dr. Kolodziejczyk has advised the United Nations Organisation for Economic Co-operation and Development, G20, and European Commission on science, technology, innovation, and policy and was named one of MIT Technology Review's Innovators Under 35 for developments of new energy materials and catalysts. Most recently, Dr. Kolodziejczyk has received the prestigious Advance Award in the Sustainability category, awarded annually to the brightest changemakers in Australia. He has published extensively, covering electrocatalysis and hydrogen generation and its application, among other energy fields. Dr. Kolodziejczyk is a Fellow of the Royal Society of Arts, a Member of the Royal Society of Chemistry, and a Chartered Environmentalist.

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Unsettled Economic, Environmental, and Health Issues of Ammonia for Automotive Applications

Abstract

Today's gray hydrogen produced from fossil fuels finds applications predominantly in gray ammonia production and crude oils processing (including vegetable oils). As such, green ammonia production will be a natural extension of the green hydrogen value chain. Ammonia has been previously trialed as an automotive fuel; however, it was not competitive with fossil fuels in terms of cost, energy density, and practicality of use—ammonia is hardly flammable. However, due to climate change, those practical and cost-related parameters have finally become secondary deciding factors in fuel selection.

Our society is in urgent need of clean fuel, and ammonia is a great candidate since it offers superior energy densities compared to compressed or liquefied hydrogen. Even though it is toxic, from a flammability perspective, ammonia is safer than most fuels, including fossil fuels. For the reasons outlined above, it is believed that ammonia might be an ultimate clean fuel choice and an extension to the emerging hydrogen economy. The so-called ammonia economy will likely start with the use of ammonia in stationary applications, including power generation. Shortly after, it will penetrate the automotive industry, where high energy densities are crucial design parameters, and then later permeate other mobility sectors.

The major unsettled issues of using ammonia as a clean automotive fuel alternative include a lack of regulations and standards for automotive applications, technology readiness, safety perception, and presently limited supply. Today's ammonia production is estimated to contribute roughly 1.8% of global carbon dioxide (CO_2) emissions. Decarbonization of the ammonia value chain is of great international interest.

This report discusses the unsettled aspects of emerging ammonia fuel and its use in automotive applications. It provides knowledge and views on the economics of green ammonia production and safety, environmental, and health issues related to its use. The report concludes with a series of recommendations related to enabling cost-competitive green ammonia production and various considerations related to the safety and environmental aspects of using ammonia fuel in the automotive industry. While ammonia as a fuel is still in its infancy, identifying and addressing those challenges early on will enable a safe and smooth transition.

NOTE: SAE EDGE™ Research Reports are intended to identify and illuminate key issues in emerging, but still unsettled, technologies of interest to the mobility industry. The goal of SAE EDGE™ Research Reports is to stimulate discussion and work in the hope of promoting and speeding resolution of identified issues. These reports are not intended to resolve the challenges they identify or close any topic to further scrutiny.

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