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Advancements in hydrogen generation, storage, and utilizations: A comprehensive review of current trends in Bangladesh

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ABSTRACT

Bangladesh is a developing country heavily reliant on fossil fuels, which emits toxic gases during its combustion. In that scenario, hydrogen is an eco-friendly fuel source with a calorific value of 120 MJ/kg which is significantly higher than fossil fuels. With a density of 0.09 kg/m^3 at 273 K, hydrogen is just 1/14th that of air. Considering the enriched agricultural resources of Bangladesh, biomass gasification emerges as the most advantageous method for hydrogen production. Compared to other methods like steam reforming and electrolysis, biomass gasification offers significant cost advantages. Furthermore, being an overpopulated country generates significant organic waste annually. The mismanagement of these wastes creates problematic situations for both lives and surroundings. This review approaches the way of waste management and hydrogen production and additionally discusses the current scenario, several hydrogen production pathways, utilization, and storage. This study focused on hydrogen production and utilization in Bangladesh, which will help the researchers to identify suitable and cost-effective methods to obtain the decarbonization goal in the energy sector.

1. Introduction

The escalating impact of human activities on climate change has spurred a global movement towards embracing a carbon-free energy economy [1,2]. The recent IPCC report 2021 underscores the urgency of stringent decarbonization in worldwide energy systems to curtail global warming to the critical limit of 1.5 °C. The global energy reliance 80 % on fossil fuels, 14 % on renewables, and 6 % on nuclear power [3]. This energy consumption trend is propelled due to the expanding global population and the improved living standards of individuals [4–6]. Developing countries like Bangladesh, India, Brazil, and South Africa require an annual energy consumption of 12–24 GJ per capita [7]. Hydrogen (H_2) is swiftly emerging as a transformative role in pursuing a cleaner, sustainable energy future. Regarded as a versatile energy source and a multi-purpose industrial raw material, the demand for H_2 is escalating due to its remarkable potentiality (Fig. 1). H_2 has been traditionally used in industries like ammonia and petroleum which is now seen as a potential substitute for fossil fuels. The idea of building an energy system around H_2 is quickly becoming popular.

Though H_2 holds a lot of promise still it faces challenges in its current form [9]. Most of the H_2 produced globally which is about 70 million metric tons each year generally comes from natural gas and coal processes that making up 95 % of the total [10], but this mix leads to emitting about 10 kg of CO_2 for every kilogram of H_2 production. On top of this, waste generation is one of the major problems of the world. It is expected to generate a lot more solid waste by 2050 that is around 70 % more than in 2016 which could add up to more than 2.6 gigatons of CO_2 emissions [11]. After addressing this issue H_2 can be produced from waste utilizing biomass gasification which not only minimizes the waste but also useful for ensuring energy security. Moreover, waste pyrolysis can work alongside other processes to make energy and H_2 [12]. However, H_2 is a bit complicated to handle. Its physical and chemical behaviors make a challenge while storing and moving. It doesn't pack a lot

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