Current Status and Prospect of Hydrogen-based Energy Industry in Indonesia for Korean Companies

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Introduction

Energy security and sustainability are amongst the huge topics of discussion in every summits due to the continuous increment of global energy demand. Furthermore, fossil fuel as one the most widely used energy sources is no longer reliable since it causes several issues such as global warming and negative environmental impacts. As a member of renewable energy sources, hydrogen-based energy is promising as a game changer, one of the major energy solutions for the future. The Indonesian Government and related stake holders have put efforts to establish hydrogen-based energy ecosystem. Indeed there are challenges faced and opportunities available along the way. This article mainly addresses the current status of research and development of hydrogen-based energy industry in Indonesia. As Korea is amongst the leaders in hydrogen-based energy, various business opportunities and cooperation in Indonesia that readily available for the benefit of both countries are also discussed.

Indonesia's Hydrogen Energy Goals & Objectives

The world population is estimated to reach 10 billion in 2050s. Indeed, the energy demand will also increase exponentially to fulfill the needs of the society in various sector. Fossil fuels as primary energy resources should be replaced with renewable energy sources since the use of fossil fuels has negative impact on the environment such as climate change and global warming due to the greenhouse gas (GHG) emissions.[1] Several countries are reducing GHG emission by implementing renewable energy sources such as solar, wind, tidal, and also hydrogen energy. Indonesia has targeted to reduce GHG emissions by 29% (business as usual – self effort) or 41% (with international assistance) by 2030, which in line with Nationally Determined Contributions. Furthermore, from Indonesia's energy sectors also specifically committed to reduce GHG emission more than 314 million CO_2 by 2030 with several strategies including

renewable energy development, energy efficiency implementation, energy conservation, and green energy technology application.[2]

From transportation sectors, it is understood along with battery electric vehicles (BEV), fuel cell electric vehicles (FCEV) produce zero emissions and they are classified as zero-emissions vehicles. Many countries have developed and implemented hydrogen strategies for their future electrification and the hydrogen demand also increases in the recent years (Figure 1a) for gas network use (residential, commercial, industrial buildings), mobility, and electricity. ERIA reports also projected that from East Asia Summit (EAS) region, Indonesia is amongst the highest hydrogen supplier by 2040 (Figure 1b).[3]

The deployment of hydrogen-energy based system confronts several challenges. Cost is still major barrier. The cost of hydrogen needs to be significantly reduced throughout the hydrogen supply chain, including production, transport, storage and usage. Specifically, regarding the hydrogen production process, to be the production of “green” hydrogen remains high cost. There are commonly four types of hydrogen based on production method, i.e. grey, brown, blue, and green hydrogen. Grey hydrogen is commonly produced from natural gas in a methane reformation process. Along with it, brown hydrogen is produced from coal gasification. These are considered as the “highest CO_2 emissions” methods. Blue hydrogen is normally produced using fossil fuels, however, it is followed by CCS (Carbon Capture Storage) process. Finally, green hydrogen is considered a “clean” method, since it is produced using renewable sources for example solar and wind energy through water electrolysis. To date, only about 4% of green hydrogen is produced.[4,5]

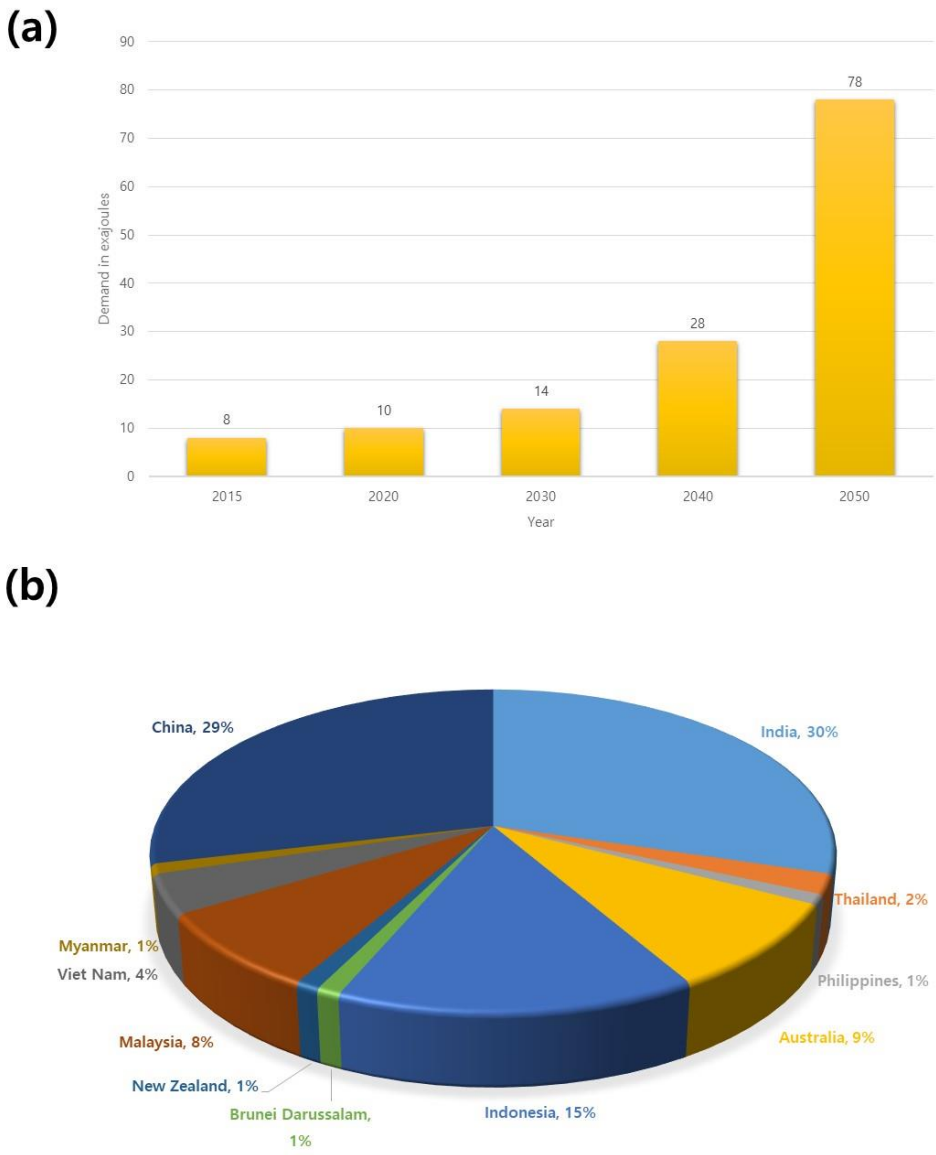

Figure 1. (a) Projected global demand for hydrogen from 2015 to 2050 (Statista, 2022). (b) Hydrogen supply forecast by countries (ERIA, 2019).

Hydrogen Energy Research and Development in Indonesia

Research and development activities on hydrogen energy in Indonesia have been relatively significant at several universities and research institutes. BPPT (Agency for the Assessment and Application of Technology), now BRIN (National Research and Innovation Agency), is one of national institutions that engages in research, development, assessment, and application of technology, works closely to industry, towards products commercialization. BPPT has been

developing hydrogen energy related applications, including fuel cells for more than a decade. Several practical prototypes have been introduced, i.e. polymer electrolyte membrane fuel cell (PEMFC) that is used as a backup power to the server at BPPT office (Figure 2a). It also introduced fuel cell motor cycle that could reach 750 km by a single refueling (Figure 2b). BPPT have also collaborated with Toshiba Energy Systems & Solutions Corporation (Toshiba ESS) Japan on the development of hydrogen-based energy supply system, called H_2One, with a capacity of 10 kW.[6]

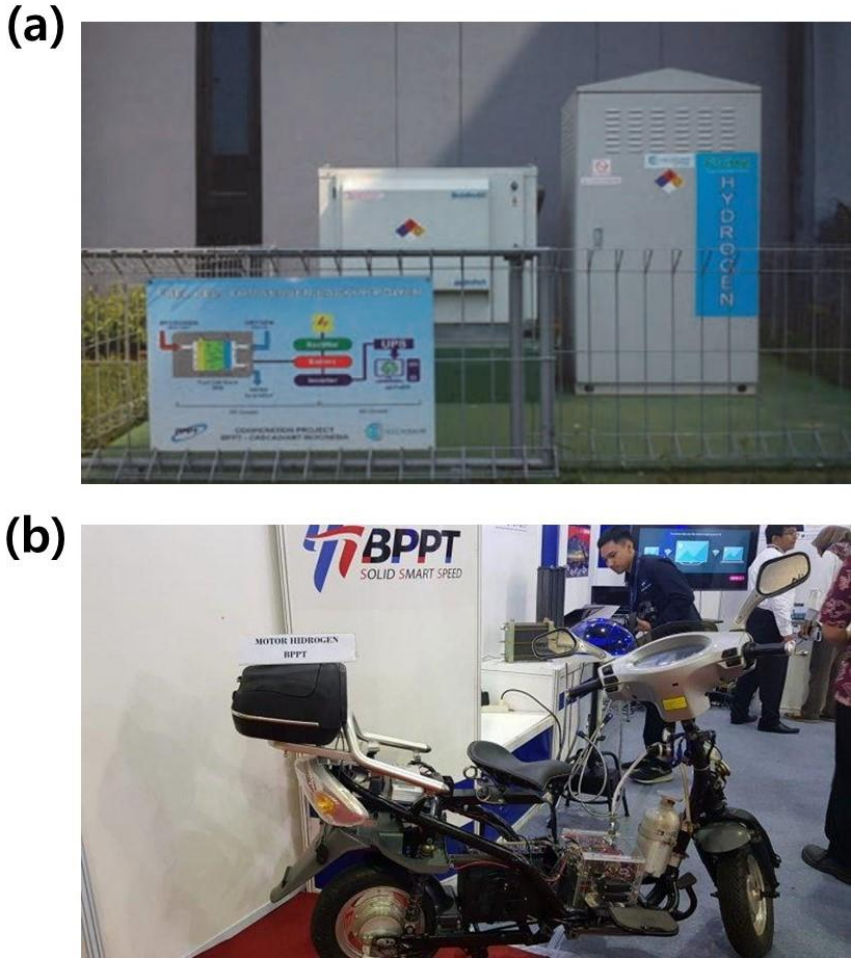

Figure 2. (a) Backup server at BPPT office using PEMFC tehnology (Riza, Renewable Energy Research in Indonesia, 2019). (b) A prototype of fuel cell motor cycle developed by BPPT (TribunNews, 2019).

PT HDF Energi has initiated to implement hybrid green hydrogen utilizing solar

photovoltaic/wind in Sumba Island (east part of Indonesia) with a capacity of 7-8 and 1-2 MW at daytime from solar and at nighttime from hydrogen storage, respectively. PT Pertamina, a state-owned company, aims to produce the first green hydrogen with daily target of 100 kg in Ulubelu region by 2023. PT Pertamina is now processing the environmental permit from the Ministry of Environment and Forestry. It is required to obtain environmental impact analysis (AMDAL) for the project. Note that the project is more of a pilot project to support the National Energy Policy, while the commercial scale projects are not yet available. Figure 3 summarize the milestones of research and development activities on hydrogen energy system in Indonesia. Institutions such as University of Indonesia (UI), LEMIGAS (a research center for oil and gas technology development under the Ministry of Energy and Mineral Resources), Surabaya Institute of Technology (ITS), PT Telkomsel, and PT KAI (Indonesian Railways Company) contributes significantly in the development of hydrogen-energy based applications. In addition, to date the relevant government and private institutions that have involved in green hydrogen project development from energy and financial sectors as follows: Ministry of Industry, Ministry of Finance, Ministry of Investment, Ministry of Energy and Minerals, PT Pertamina, Pupuk Indonesia, and PLN (Indonesia Power), and PT HDF Indonesia and Fortescue Future Industries (FFI).[6]

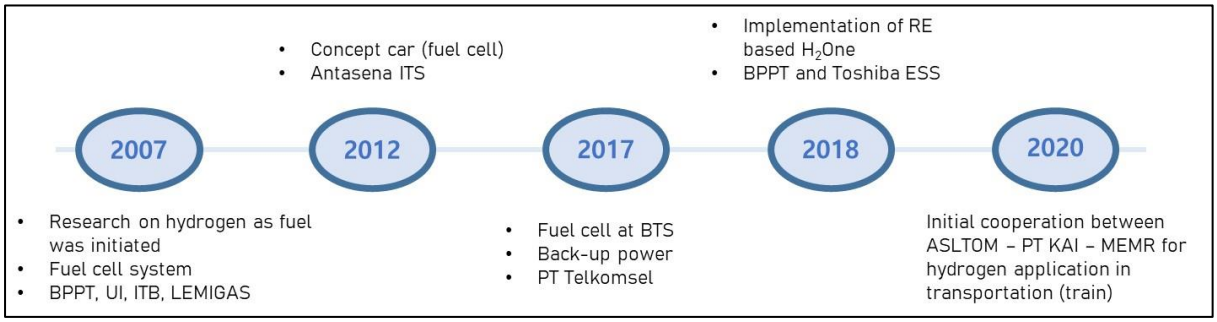

Figure 3. Overview of research and development of hydrogen-based energy system in Indonesia.

Hydrogen Energy Regulation in Indonesia

Hydrogen is a one of the keys to future energy system. Although Indonesian government has not developed or issued any detailed regulation on hydrogen-based energy yet, the Government strongly encourages renewable energy development to reach 23% and 31% of energy mix by

2025 and 2050, respectively (National Energy Policy in 2014, Government Regulation No. 79/2014). Previous Presidential Regulation in 2009 and 2017 also supported the development of fuel cell technology. Note that there are several conditions and challenges that need to be considered to develop the hydrogen or renewable energy system, such as over-supplied on electricity sector, the decline on national crude oil productions, and minimum subsidy in energy sectors. Indeed, the Government is encouraged to understand the importance of green hydrogen for achieve climate neutral/net-zero emission target.

Ministry of Energy and Mineral Resources has also initiated a study on green hydrogen in Indonesia in cooperation with German government through *Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH* (GIZ). It has also planned to utilize hydrogen energy for Ibu Kota Baru (the New Capital City) in 2045 for transportation system and industrial sector. Therefore, it is also worth noting that current situation facilitates the development of hydrogen energy through foreign direct investments (FDI).

Opportunities for Korean Companies

It is understandable that using hydrogen-based energy would be an energy storage solutions for off-grid system as well as reducing oil consumption by enabling fuel cell vehicles. In the green hydrogen sector, the Indonesian government indeed needs a financial and technology supply from foreign investors. Although the hydrogen price is still not stable; its price is still moving. Currently, the green hydrogen price is in the range of $2 – 6/kg. It is also worth noting that with the current scenario, it has been evaluated that deployment of this hydrogen technology is 'bankable', meaning with proper strategy from Indonesian government in the near future, this technology will be more feasible.

Korea is one of the pioneers in hydrogen-based energy application. In 2013, Hyundai released the first commercially produced hydrogen fuel cell automobile followed by the second-generation Hyundai Nexo in 2018 as the most powerful FCEV in the market with EPA rated range of 611km. However, the challenge in the distribution of FCEV is the lack of infrastructure such as the availability of H_2 refueling stations. In the near future, it is projected a number of H_2 refueling station will be constructed and FCEVs could find their places.

Korean companies may also penetrate the market not only in Indonesia but also the neighboring countries (ASEAN), starting from the up-stream all the way to the down-stream products.

Korean institutions have established a significant hydrogen-based energy electrification, for example in Busan City, to support Hydrogen Economy Roadmap. The city aims to utilize 100% of the energy from renewable sources by 2050. As a part of plan, the hydrogen fuel cell power plant was constructed, consisting of 70 hydrogen fuel cells with a total 30.8 MW of capacity. The facility is able to annually sell 250,000 MWh of electricity to Korea Electric Power Corporation (KEPCO), equivalent to 13.8% of Haeundae District's electricity consumption.[7] Moreover, several cities in Korea have also developed H_2 refueling stations and introduced hydrogen-powered public buses.[8] This technology implementation could be transferred in Indonesia, for example in Surabaya City as a Busan's Sister City, as well as other cities.

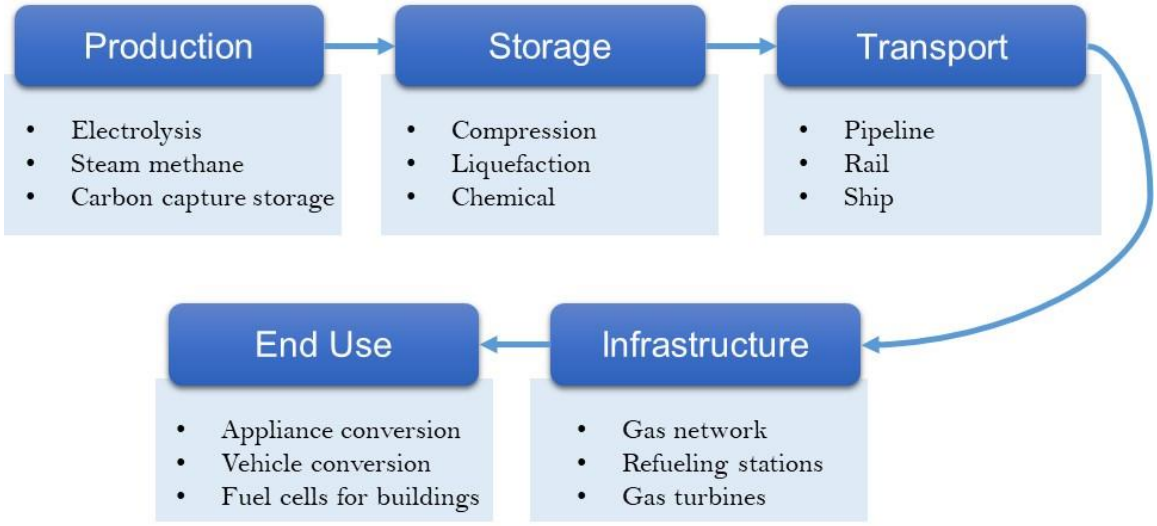

Figure 4. Hydrogen value chain (KPMG, 2021)

Figure 4 further shows the hydrogen value chain that has business potentials for Korean companies to involve.[9] In the production part, Korean companies that have mature technology and experience on the development and commercialization of renewable energy can facilitates the production of green hydrogen. In addition, carbon capture storage (CCS) also will be good business for Korean companies to take part. Moreover, the materials or catalysts used in fuel cell technology will be in high demand. This hydrogen business not only for companies with hydrogen production and storage technology but also for transport companies that have technology used for transmission pipeline, tube, rail, as well as ship. Another huge opportunity is in the infrastructure part. Distribution gas network, refueling stations, and has turbines will

be needed to support the deployment of hydrogen-based application such as fuel cell electric vehicles and fuel cell for residential, commercial, or industrial buildings.

Concluding Remarks

Along with other renewable energy sources, the Indonesian Government and various stake holders are striving to build a hydrogen-based energy ecosystem which aim to achieve 23% of renewable energy in national energy mix by 2025. These are part of the efforts to fulfill the National Energy Policy target and Paris Agreement Commitment. For the future, hydrogen energy will also play significant role to realize the energy demand which is clean and sustainable. The Government is constantly developing policies and regulations to support renewable energy including hydrogen energy implementation. Numerous business opportunities from hydrogen value chain are also open, especially for Korean companies that have advanced hydrogen energy technology. Finally, Indonesia always opens up for the cooperation for green hydrogen developments with various countries.

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