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Challenges and Opportunities of Green Hydrogen Production in Indonesia

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Abstract: Global climate change necessitates deep decarbonization of all economic sectors due to significant greenhouse gas emissions. Indonesia has committed to reduce emissions by adding the share of renewable energy contribution to the nation's energy mix. Hydrogen emerged as a key element in the energy transition due to its environmentally friendly and diverse applications in energy and industry sectors. This analysis examines the challenges and opportunities of Green Hydrogen (GH_2) production in Indonesia to achieve the nation's carbon reduction and sustainability goals. By leveraging the enormous renewable energy potential, Indonesia is economically viable to implement GH_2 production starting in 2031, aligning with the National Hydrogen Strategy. The study highlights the potential benefits of GH_2, such as reducing greenhouse gas emissions, supporting net zero targets, creating green jobs, and increasing renewable energy integration. Additionally, the analysis emphasizes the importance of government support in technical regulations, pricing policies, incentives, and infrastructure development to accelerate the green hydrogen transition and establishment.

Keywords: *green hydrogen, renewable energy, sustainability*

I. INTRODUCTION

Global climate change is a major international focus due to its severe consequences. Natural disasters caused by climate change can lead to significant economic losses, depletion of natural resources, and damage to social and cultural environments. The Intergovernmental Panel on Climate Change's (IPCC) 6th Assessment Report (AR6) [1] highlights that the negative impacts and associated damages worsen with every increase in global temperature.

Limiting global warming requires deep decarbonization of the whole nation's economy. Electricity and heat production are key sectors influencing greenhouse gas emissions, accounting for approximately 25-30% of these emissions [1]. Therefore, a primary step in achieving carbon reduction goals in the economy is to increase the share of renewable energy sources with minimal carbon emissions and reduce the share of coal in electricity production.

According to a report by [2], Indonesia committed to reduce its greenhouse gas emissions by modifying the primary energy mix, with the objective of diminishing the proportions of coal and oil and augmenting the proportion of renewable energy sources. The nation's aims to decrease the coal contribution from 43% to 30% and oil from 31% to 25% from 2020 to 2030, while increasing the contribution of renewables from 6,1% to 25%. As part of its Enhanced Nationally Determined Contributions, Indonesia has committed to achieving a 31.89% reduction in GHG emissions by 2030. Additionally, Indonesia aims to reduce carbon emissions in the energy sector by 358 million tons of CO_2e by 2030 and achieve Net Zero Emission by 2060 [3].

Indonesia has the biggest energy market in Southeast Asia, making up more than 36% of the region's energy demand. Electricity demand in Indonesia is projected to grow steadily, it may reach 479 TWh by 2033 driven by continued economic and demographic growth [4]. Indonesia's electricity demand was about 285 TWh in 2021, divided mainly between residential (41%) and industrial (36%) sectors. Java-Bali Island used about 70% of the electricity, while Sumatra used around 15%. Residential demand is increasing due to population growth and space cooling (Figure 1.) [5].

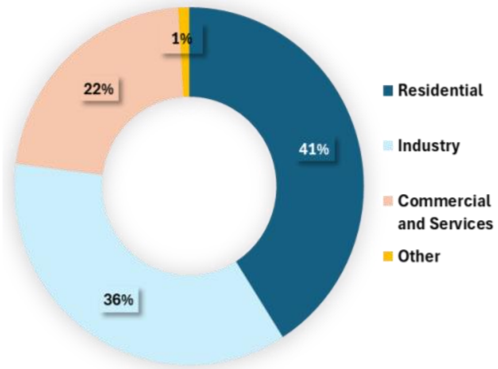

Figure 1. Electricity Demand by Sector in 2021 [5].

Indonesia has relied mainly on fossil fuels for electrification, the electricity generation (310 TWh in 2021) primarily comes from thermal power plants, the coal dominated about 61% and natural gas contributed around 17% of the electricity (Figure 2) [5]. The National Energy Plan 2019–2038 was released by the Indonesian Ministry of Energy and Mineral Resources to establish the country's future goals for electricity [6]. It includes policy reforms to encourage investments in renewable energy, reduce the nation's reliance on fossil fuels. This approach outlines strategy for sustainable energy development and emphasize the importance of cleaner sources in Indonesia's energy portfolio [5]. Indonesia should decommission existing fossil fuel power plants and construct more renewable energy power plants and energy storage to achieve the net-zero emissions target [7].

Hydrogen (H_2) has the potential to become a key element in the transition to clean energy sources and reducing dependence on hydrocarbons. Hydrogen is a renewable energy source with various applications, including as feedstock for chemical production, transportation fuel, and energy sources for power plants [8]. Hydrogen can be produced from a variety of energy sources, including renewable (ex. solar and wind) and non-renewable (eg. natural gas and coal). Currently, the main sources of hydrogen production are fossil fuels. Approximately half of the hydrogen comes from natural gas, 30% from oil, and 15% from coal, which are not always considered environmentally friendly [9].

Hydrogen energy can be categorized based on how it is produced. Gray Hydrogen produced from natural gas through steam reforming and releases significant CO_2 emissions, which are unsuitable for climate change mitigation [10]. Blue Hydrogen is produced from natural gas, then the carbon emissions are captured and stored using Carbon Capture and Storage technologies. This reduces CO_2 emissions but requires substantial investment and infrastructure development [11]. Green Hydrogen is generated by water electrolysis using renewable energy sources like solar or wind power, resulting in no carbon emissions. It is considered environmentally friendly and supports the transition to clean energy [12, 13].

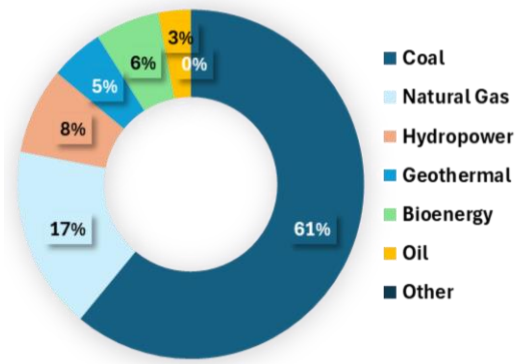

Figure 2. Electricity Generation Mix in 2021 [5]

Green hydrogen (GH_2) is considered the most preferred option [14]. [15, 16] also explained that GH_2 is vital in the energy transition and could decarbonize difficult-to-abate sectors significantly. However, GH_2 energy transition in Indonesia is faced with challenges, including uncertainty of supply-demand, hydrogen energy policy, unformed hydrogen market, infrastructure barriers, and limited Investment [3]. The investment in new renewable energy requires high capital due to the lack of support from domestic industry in the new renewable energy component and the difficulty of obtaining funding or loans with low interest [4]. In spite of that, Indonesia has strong capital to support hydrogen development, including abundant potential for renewable energy resources, commitment to global climate mitigation, and Indonesia's position as an archipelagic country located in international trade routes. Supply of GH_2 from new renewable energy is planned to start in 2031 in Indonesia, this will decarbonize approximately 388 million tons of CO_2 [3].

According to the National Energy Council Republic of Indonesia, Indonesia has a 3687 GW renewable energy potential, made up of 63 GW of ocean power, 23 GW of geothermal energy, 57 GW of biopower, 155 GW of wind power, 95 GW of hydropower, and 3294 GW of solar power (Table 1.). The use of renewable energy sources for GH_2 production must be further optimized to increase the overall utilization of renewable energy in Indonesia, which is currently only 0.3% [4].

Table 1.
Indonesia's Renewable Energy Power Plant Potention and Utilizatoon in 2022 [4]

Type of Renewable Energy	Total Potential (GW)	Utilization (GW)	% Utilization
Ocean	63	0	0,0%
Geothermal	23	2,4	10,4%
Bioenergy	57	3,1	5,4%
Wind	155	0,2	0,1%
Hydro	95	6,7	7,1%
Solar	3294	0,3	0,0%
Total	**3687**	**12,7**	**0,3%**

The first GH_2 Plant (GHP) in Indonesia was inaugurated in 2023 by PT PLN (Perusahaan Listrik Negara) as the government-owned corporation which holds the monopoly on the ownership and operation of transmission and distribution assets in Indonesia. The first GH_2 plant is powered entirely by solar energy and can produce 51 tons of hydrogen annually. Of this, 43 tons can fuel 147 cars to travel 100 km daily [4]. [17], also report the economic viability of GH_2 production in Indonesia using small hydropower plants. In order to assess the opportunity for hydrogen energy transition in Indonesia, this study was conducted. The aim of this study is to understand the challenges and opportunities of GH_2 production in Indonesia. Analysis from various resources related to GH_2 energy was carried out to achieve the goal.

The scientific basis of this study is the analysis of published articles and journals focusing on energy transition to new energy sources and adoption of the development and realization of national potential in the production of GH_2 energy. This includes an analysis of the current state of demand in GH_2 energy industry, an assessment of renewable energy sources, and an overview of activities in the field of hydrogen economy in Indonesia. This study used open-source information, including the latest reports and national renewable energy strategies and regulations, to evaluate Indonesia's potential for hydrogen production and identify future hydrogen strategy priorities.

II. INDONESIA'S HYDROGEN OVERVIEW

Indonesia is an archipelagic country with around 6,000 inhabited islands. Geographically, many islands are separated by deep water, posing a challenge for creating a nationally connected electricity network. Additionally, many islands have significant renewable energy potential that has not been fully utilized due to the uneven growth in electricity demand. Conversely, some areas with high population density and energy demand lack adequate renewable energy sources. Electrical energy from renewable sources, such as solar and wind, is also intermittent. Therefore, energy storage technology will be needed to overcome this intermittent nature. The major electricity generation in Indonesia still depends on fossil fuel production. Hydrogen has the potential to overcome these challenges and diversify the country's energy mix, which aligns with Indonesia's commitment to reduce total carbon emissions by adding more contributions to renewable energy resources.

A. Green Hydrogen Demand

Green hydrogen is being harnessed as a clean alternative across various sectors, including electricity generation, public transportation, maritime, and aviation industries [18]. Its adoption is crucial in advancing environmental sustainability and mitigating carbon emissions, marking a significant step towards a greener future. Hydrogen demand in Indonesia is currently around 1.75 million tons per year in 2021, almost entirely for the chemical and refining subsector, dominated by use for urea (88%), ammonia (4%), and oil refineries (2%). Most of the hydrogen currently used in Indonesia comes from natural gas. In electricity, GH_2 play roles including co-firing in fossil power plants to reduce emissions, energy storage for remote areas to support full electrification, and help mitigate the intermittency of renewable energy in the national grid.

The green hydrogen demand expected steadily grows as the increase of electricity and electromobility demand in Indonesia. This is also supported by the nation's policies in promoting net zero emissions and strategic initiatives to develop hydrogen economy. Per capita electricity consumption is projected to increase from less than 1,000 kilowatt-hours (kWh) in 2021 to over 1,500 kWh in 2030, and around 4,400 kWh by 2060 [14]. By 2060, transportation will be the second-largest consumer of electricity. [19] shown that transport electrification can only effectively reduce CO_2 emissions if its electricity demand is generated from renewable energy sources. Transport electrification with large scale integration of renewables could lower the annual costs by decreasing fossil fuel costs in the transport and electricity sectors.

Based on the Ministry of Energy and Mineral Resources' Net Zero Emission modeling, demand for low-carbon hydrogen from various sectors is projected to grow in 2031 – 2060. The low-carbon hydrogen demand growing from around 0.2 PJ (equivalent to 26,000 barrels of oil) in 2031, up to 34.3 PJ in 2040, and peaking to reach 609 PJ in 2060 as can be seen in Figure 3. The use of low-carbon hydrogen for transportation begins in 2031 equivalent to 26,000 barrels of oil or 0.04 TWh (truck transportation) growing 52.5 million barrels of oil or 89 TWh (shipping and truck transportation) in 2060. In the industrial sector, the use of low-carbon hydrogen will begin in 2041, equivalent to 2.8 TWh to 79 TWh in 2060 [3].

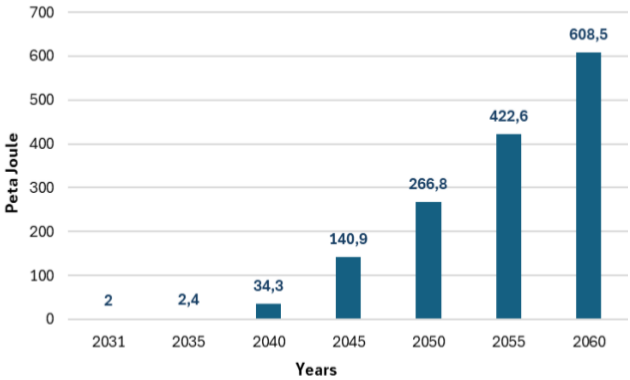

Figure 3. Hydrogen Demand Projection in NZE Model

B. Green Hydrogen Supply

Indonesia's geographical features support energy production from its abundant renewable energy resources, as mentioned in Table 1. Most areas of Indonesia have an annual solar irradiation intensity of around 1,600 kWh/m2-1,800 kWh/m2. Wind resources in Indonesia have a speed of 4 m/s-7 m/s, and technically, the potential reaches 60 GW (on-shore) and 188 GW (off-shore). Additionally, Indonesia is an archipelagic country with huge hydro resource potential [3]. The utilization of these natural energy resources must be optimized to produce low carbon emission electricity output.

The generated electricity from renewable resources powers an electrolyzer, which splits water (H_2O) into hydrogen (H_2) and oxygen (O_2). The resulting hydrogen gas from electrolysis is collected and stored in a specialized H_2 tank, which is transported to an H_2 pipeline for distribution to end-users [20]. The Indonesian Ministry of Energy and Mineral Resources analyzed the potential location of green hydrogen production in Indonesia, as shown in Figure 4. Nusa Tenggara has the most significant potential, several provinces are also predicted to be able to produce GH_2 far above the national average, such as West Java, Central Java, East Java, Papua, Riau, and South Sumatra. The nation's total GH_2 production capacity is expected to grow over the years as the development of the regulatory framework, enhancement of technology, and infrastructure of hydrogen energy [3].

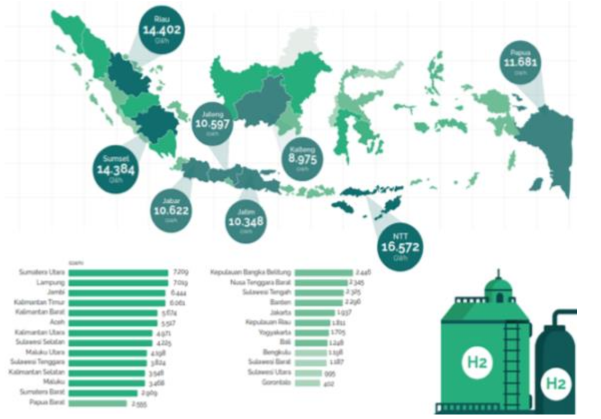

Figure 4. Distribution Map of GH_2 Production Potential in the NZE Model

International Energy Agency (IEA) announced projects on green hydrogen production which classified by technology route and status, from concept to operation (Figure 5). Based on the figure, status of GH_2 production in Indonesia mostly on early stages and there's one under construction project. In 2020, Germany, Spain, Canada and Russia have developed a hydrogen development strategy that is formulated by the end of 2020 to produce around 52% hydrogen globally. Around 2030, it is estimated that the European Union will build around 2x40 GW of renewable energy through electrolysis with a yield of 10 million tons of hydrogen [21]. Summary of the current production and development of GH_2 in ten countries were made in Table 2.

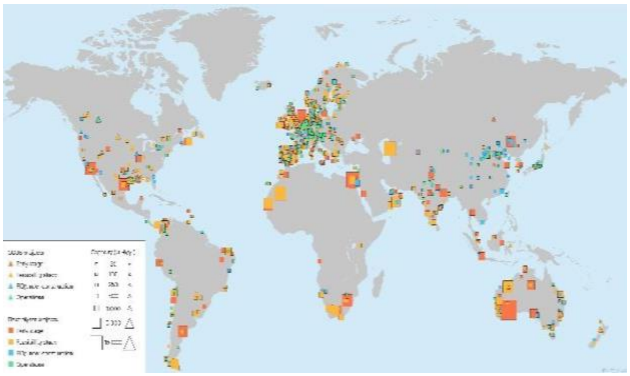

Figure 5. Map of Announced Low-Emission Hydrogen Production Projects.

Table 2.
Summary of Current Green Hydrogen Production and Challenges

Country	Current Status of GH_2 Production	Potential GH_2 Production by 2030	Government Policies & Initiatives	International Partnerships
Australia	Emerging leader; significant investments in GH2 production for export.	Potential to produce over 8 GW by 2030 utilizing solar and wind energy sources	National Hydrogen Strategy, includes incentives, regulatory frameworks, and a focus on international collaboration to become a leading GH_2 exporter.	Strong ties with Japan, South Korea, and Germany for GH2 export.
Japan	Advanced R&D; focus on hydrogen economy, including GH_2.	Limited domestic production; focus on imports for GH_2 needs. by 2030, 15 GW of water electrolysers are expected to be installed by Japanese-related companies globally.	(Revised) Basic Hydrogen Strategy, subsidies for hydrogen infrastructure, and technology.	Collaborations with Australia (New Zealand), Europe, and Middle East.
South Korea	Significant investments; focus on hydrogen economy and fuel cell vehicles.	Potential to produce5 GW by 2030 using solar, wind, tidal, biomass, and hydro energy sources; Building of 70 liquid hydrogen fuelling stations by 2030; aiming to supply 1.94 million tons of hydrogen per year by 2030	Hydrogen Economy Roadmap, substantial investment in hydrogen refueling stations; provides installation subsidies to promote the initial expansion of hydrogen fueling stations and other infrastructure related to GH_2 production; and regulatory support for clean hydrogen production.	Partnerships with Australia, Saudi Arabia, and the US for hydrogen supply. Also partners with Japan, Australia, and Germany involving joint projects for the production and transportation of hydorgen, technology exchange, and hydrogen infrastructure development.
China	Rapidly expanding; world's largest hydrogen producer, including GH_2.	GH_2 production capacity to roughly 7.7 million tonnes per year by 2030 utilizing Solar, Wind, Hydro energy sources	14th Five-Year Plan includes hydrogen as a strategic industry (Developmet of the Hydrogen Energy Industry 2021-2035)	Partnerships across Asia and Europe, significant domestic investment.
India	Emerging focus on GH_2; focusing on research and pilot projects across various sectors, have an ambitious targets set for future production.	Set a target of 450 GW of renewable energy capacity by 2030 utilizing solar, wind, and biomass energy sources.	National Hydrogen Mission, focusing on scaling up renewable hydrogen production with a focus on industrial applications and international collaboration. Public-private partnerships, and financial incentives to boost production and R&D.	Collaboration with Japan, Australia, and the EU for hydrogen projects.
Vietnam	Early-stage exploring GH_2 potential, focusing on renewable energy.	Potential to produce 2-5 GW by 2030 using solar and wind energy sources. The existing hydrogen primarily produced from non-renewable sources.	National Energy Development Strategy, which targets hydrogen production as part of its 2030 and 2050 energy plans.	Partnerships with Japan and Europe for technology and investment.
Thailand	Early stages; started piloting green hydrogen combined with fuel cell systems for power generation	Potential to produce 2 GW by 2030 using solar and wind energy sources.	Substantial planned investments, international partnership, Electrolysis Capacity Expansion. Existing regulations and technology infrastructure are not yet fully dereloped.	MOU with a Saudi renewable developer to develop a large-scale green hydrogen production facility in Thailand
Philippines	Limited; exploratory phase focusing on hydrogen as part of energy transition.	Potential to produce 1-2 GW by 2030 utilizing geothermal, hydropower, wind, solar, biomass, and ocean energy sources.	National Renewable Energy Program (NREP) exploring hydrogen potential . The Philippines Department of Energy also started initiatives of Hydrogen Energy Release Optimizer (HERO) program to promote green hydrogen.	Partnerships with Japan and Korea for feasibility studies and pilot projects. MOU with Star Scientific for exploring hydrogen potential.
Malaysia	Developing interest; initial projects focusing on hydrogen technology.	Projected to produce up to 20 GW (gigawatts) of energy from hydrogen using solar and hydro sources.	National Energy Policy includes early-stage regulations and incentives for hydrogen production, with a focus on technology transfer and capacity building.	Collaborations with South Korea, Japan, and Australia to derelop hydrogen production and technology.
Indonesia	Potential underdeveloped; early-stage initiatives and roadmap development.	GH_2 development will begin in 2031 utilizing hydro, solar, geothermal, wind energy. GH_2 generation capacity will increase from 328 MW in 2031 to 2035, 332 MW in 2036 to 2040, 9 GW in 2041 until 2050, and 52 GW in 2051 to 2060.	Indonesia's national hydrogen strategy developed on 2023. Emerging regulations under the Energy Transition Roadmap focus on scaling renewable energy sources, with GH_2 as a key component of Indonesia's long-term strategy.	Need of international support for financing and technology transfer.

III. INDONESIA'S HYSROGEN ECONOMICS

Green hydrogen production depends on factors like yield production of renewable power plants, electrolyzer technology, and GH_2 infrastructure readiness. The increase in renewable power plant yield production may drive down the cost of electricity production and in turn, reduce the cost of the GH_2 production. [3] mention that 70 % of GH_2 price is determined by electricity price from renewable sources besides the initial investment (electrolyzer technology). The average selling price of electricity per kWh in 2022 is IDR 1,137/kWh (7 cents, exchange rate Rp. 16.251,47). In order to achieve price competitiveness in GH_2 energy, Indonesia must pay attention to the pricing policy for renewable energy power plants. The determination of electricity tariffs by the government is regulated in MEMR Regulation No. 3 of 2020 concerning the Fourth Amendment to MEMR Regulation No. 28 of 2016 concerning Electricity Tariffs provided by PT PLN (Persero).

Currently, there are four electrolysis technologies supported for green hydrogen production, including alkaline water electrolyzer (AE), proton exchange membrane electrolyzer (PEM), solid oxide electrolyzer (SOE), and anion exchange membrane electrolyzer (AEM) [37]. According to [38], AE stands out among other electrolyzers due to the longest lifespans, lowest capital expenditures (CAPEX), and highest technology readiness level. This durability, with lifespans surpassing 30 years and high scalability, has been supported by most manufacturers since the early 1900s.

Indonesia's Hydrogen Strategy mentioned the GH_2 production aims to start in 2031. The electrolyzer cost prediction was reported by previous studies considering factors like scale-up, manufacturing volumes, and technology improvements. [39], predicts that the gap in CAPEX between AE and PEM technologies is expected to narrow significantly as plant sizes increase. For very large plants (greater than 100 MW), the costs for both technologies will approach 320-400 USD/kW by 2030. The electrolyzer capital costs will be estimated to drop to 88 USD/kW for AE and 60 USD/kW for PEM under an optimistic scenario by 2050, or 388 USD/kW and 286 USD/kW, respectively, under a pessimistic scenario [40]. According to [41], the initial investment of AE may costs 500-1400 USD/kW, 1100-1800 USD/kW for PEM, and 2800-5600 USD/kW for SOE. Electrolyzer manufacturers generally agree on the potential for rapidly reducing capital costs through economies of scale [37].

The average cost of GH_2 production consists of investment and operational costs, which are defined using the Levelized Cost of Hydrogen (LCOH). LCOH accounts for all capital and operating production costs in a levelized manner over a unit of produced hydrogen and its derivative (USD/kg) [42]. By 2030, the global LCOH for GH_2 is predicted to be less than 5 USD/kg for solar, onshore wind, and offshore wind energy sources due to lower electrolyzer costs and the Levelized Cost of Electricity (LCOE) in both scenarios [40]. Based on [3] calculations by taking three PLN case studies, the price of hydrogen production is around 4.61-5.45 USD/kg in 2030, assuming the cost of a PEM electrolyzer is between 450-1700 USD. In comparison, the projected hydrogen price in Japan is around 5.7–7.7 USD/kg in 2025 [43], around 5.5-7.7 USD/kg in South Korea [44], and around 4.9–6.5 USD/kg in Singapore [45]. Despite that, the projected price of GH_2 in Indonesia is not yet competitive because it is three times the current average cost of production. Therefore, the government needs to help the growth of this sector by making policies, creating an investment climate, and developing competitive business models.

Regarding energy pricing, [46] found that more than 95% of non-subsidized residential consumers in Indonesia are willing to pay up to 40% higher than the current price for greener electricity. This willingness to pay increases with the share of renewable energy in the energy mix. These findings highlight the strong potential market for greener energy solutions in Indonesia, indicating that consumers are ready to support and invest in cleaner energy alternatives.

A well-defined regulatory framework is a crucial initial step for fostering the growth and defining competitiveness of green hydrogen market. Clear regulations provide certainty and stability for industry stakeholders and investors. Given that green hydrogen may often be more expensive than existing fossil fuels, government support through clearer policies, incentives, and infrastructure readiness is essential.

Indonesia's government can play a pivotal role in hydrogen energy transition by establishing clear regulations for standards, technical production, and transportation. This includes defining greenhouse gas emission thresholds and related licensing regulations, which are crucial for ensuring that hydrogen production remains environmentally sustainable. The government can start to implement carbon pricing mechanism, similar to Australia's Carbon Pricing Mechanism (CPM) or the European Union Emissions Trading System (EU ETS).

Additionally, providing grants for hydrogen-related research and development projects, offering accelerated depreciation incentives, and financial assistance for developing hydrogen infrastructure are also critical measures. The government should encourage collaboration between the public and private sectors, along with international organizations, to promote the adoption of green hydrogen. Educational campaigns to raise awareness about the environmental, energy security, and health benefits of green hydrogen will also be needed in gaining public support and driving the energy transition forward.

Despite the challenges of supply-demand uncertainty, unformed policy, and infrastructure barriers, the benefits of GH_2 production outweigh the challenges, including reducing dependence on fossil fuels, being environmentally friendly, and providing an efficient energy carrier. [47] also shows that the use of hydrogen proves beneficial for long-term storage, whereas the electricity economy is preferable in the case of short-term energy storage. In the electricity generation sector, GH_2 serve as an energy transport medium, becoming an option to meet domestic needs and expand energy connectivity that is geographically unreachable. Additionally, GH_2 can be used as fuel for co-firing, which has the potential to reduce greenhouse gas emissions by 10,588,235 tons of CO_2-eq [3]. GH_2 as a raw material in the fertilizer supports Indonesia's potential as the 3rd-largest ammonia exporter in the world.

The economic viability of green hydrogen production in Indonesia seems a promising opportunity. [17] mentioned that GH2 production from small hydropower plants in Indonesia is economically feasible. The study found that green hydrogen production using excess electricity from small hydropower plants is a viable method for decarbonization and offers scalability for future energy production in Indonesia, with the first initial step being as a green hydrogen and natural gas co-firing fuel mixing in gas turbines. [48] also found the economic and technical feasibility of constructing a green hydrogen facility in Jambi, Indonesia. The finding highlighted Jambi's projected selling price for green hydrogen demonstrates competitiveness within the market. These findings offer valuable insights into the potential profitability and market prospects of green hydrogen. Additionally, [49] results indicate that the establishment of hydrogen production in Indonesia using fermentation technology and agricultural waste is economically viable.

Integrating green hydrogen into Indonesia's energy mix represents a transformative opportunity to decarbonize the energy sector and advance sustainability goals. By critically evaluating various aspects, including scalability, technological challenges, and socioeconomic implications, stakeholders can gain a holistic understanding of the potential benefits and challenges associated with green hydrogen. This information will aid in making informed decisions and formulating effective strategies to drive the successful integration of green hydrogen into the energy landscape [50]. Indonesia's implementation of green hydrogen production to optimize the nation's renewable sources requires careful planning, technology optimization, and infrastructure development. Government support and decisions play a crucial role in the green hydrogen energy transition.

IV. CONCLUSION

The economic analysis of green hydrogen production in Indonesia highlights significant long-term benefits, including the reduction of greenhouse gas emissions and contributions to achieving net zero emission targets and sustainability, realizing universal energy access in line with SDG 7 criteria on clean energy, creating potential for green jobs, increasing the extensive penetration of new renewable energy in the national energy mix, and supporting the strengthening of green hydrogen and ammonia exports. The potential for developing green hydrogen in Indonesia is enormous, in line with its renewable source capacity. Green hydrogen production in Indonesia is a promising opportunity and it is planned to be implemented starting in 2031, as mentioned in the National Hydrogen Strategy. The utilization of hydrogen in the electricity sector can be carried out in the long term while preparing for the development of renewable energy and massive technological stability. Green hydrogen could become one of the leading commodities in the future. Government support by preparing technical regulations, incentives, price policies, commercial mechanisms, and supporting permits is needed to accelerate the readiness of market players to conduct pilot projects and participate in the green hydrogen energy transition.

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