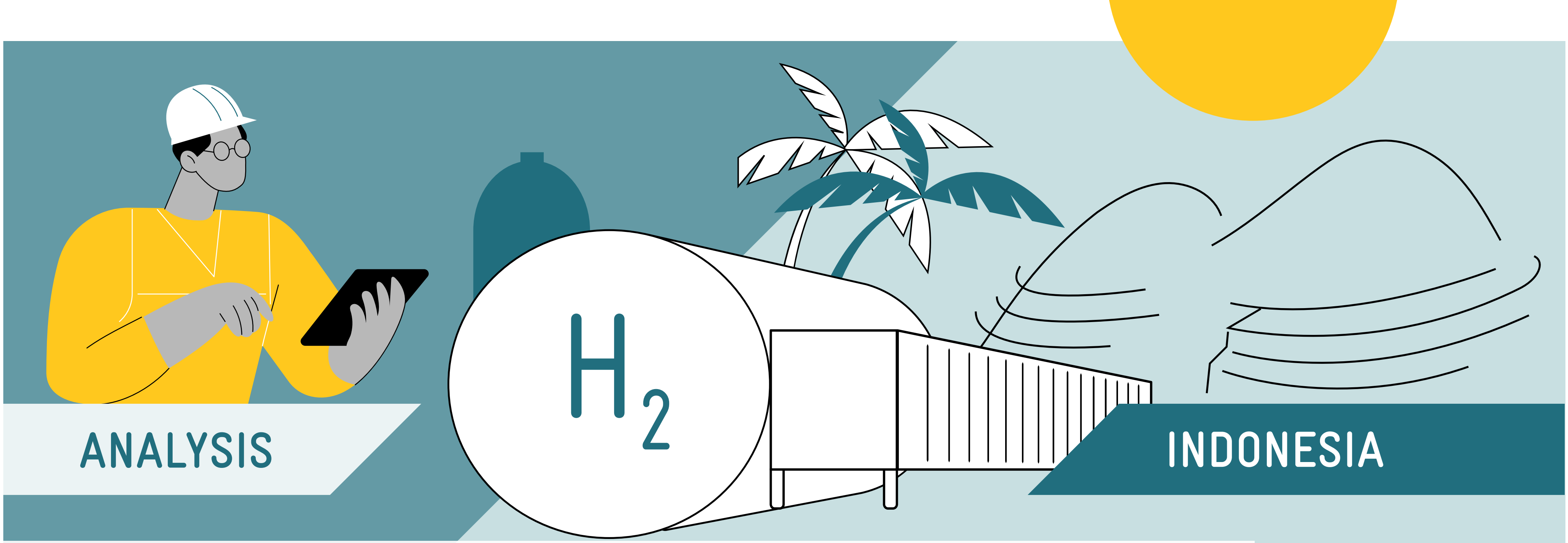

Sector Analysis Indonesia

Green Hydrogen for the C&I Sector

Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

This publication was commissioned by the German
Energy Solutions Initiative of the German Federal
Ministry for Economic Affairs and Energy (BMWE)

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Currency units

IDR	Indonesian rupiah
USD	United States dollar

Currency units and conversion rate as of 05.09.2024
EUR 1 = IDR 0.00005855
IDR 1 = EUR 0.92275

EUR 1 = USD 17,079
USD 1 = EUR 1.0838

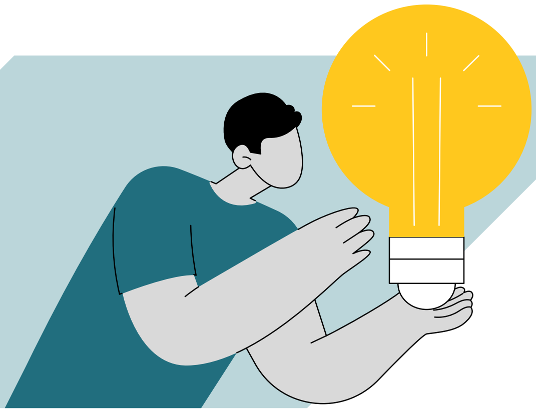
Source: Exchange-Rates.org, 2024

Technical units

bbl	Barrels (plural)
EJ	Exajoules (10^6 TJ)
GW	Gigawatt
GWh	Gigawatt-hour
kTPA	Thousand (metric) tons per annum
Mt	Million (metric) tons
MTPA	Million (metric) tons per annum
MW	Megawatt
MWh	Megawatt-hour
TJ	Terajoule (10^12 Joule)

Abbreviations/acronyms

AEC	Alkaline electrolysis
AEMEC	Anion exchange membrane electrolysis cell
AHK Indonesia	German-Indonesian Chamber of Industry and Commerce
AN	Ammonium nitrate
AS	Ammonium sulphate
ASU	Air separation unit
BAPPENAS	Badan Perencanaan Pembangunan Nasional, Indonesian Ministry of National Development Planning
BMWE	Bundesministerium für Wirtschaft und Energie (BMWE) / German Federal Ministry for Economic Affairs and Energy (BMWE)
BT	Benzyltoluene
CAN	Calcium ammonium nitrate
CCS	Carbon capture and storage
CCU	Carbon capture and utilisation
CH_2	Compressed hydrogen
CHP	Combined heat and power
CO_2	Carbon dioxide
DAC	Direct air capture
DAP	Diammonium phosphate
DME	Dimethyl ether
DMO	Domestic market obligation
DRI	Direct reduced iron
EIA	Environmental impact assessment
ETS	Emission trading scheme
EU	European Union
FFI	Fortescue Future Industries
FiT	Feed-in tariff
GGGI	Global Green Growth Institute
GH_2	Green hydrogen
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German federal enterprise in the field of international cooperation for sustainable development)
HB	Haber-Bosch
IEA	International Energy Agency
LH_2	Liquid hydrogen
LOHC	Liquid organic hydrogen carriers
LPG	Liquefied petroleum gas
MAP	Monoammonium phosphate
MCH	Methylcyclohexane
MeOH	Methanol
MTBE	Methyl tertiary butyl ether
MTG	Methanol-to-gasoline
MTO	Methanol-to-olefins
NDC	National Determined Contribution
NH_3	Ammonia
NPV	Net present value
NSP	National Strategic Project
PDP	Project Development Programme
PEMEC	Proton membrane electrolysis cell
PLN	PT. Perusahaan Listrik Negara, Indonesian government-owned corporation for electric power generation and distribution
PPA	Power Purchase Agreement
PPP	Public-private partnerships
PtX	Power-to-X (anything)
PV	Photovoltaic
R&D	Research and development
SME	Small and medium-sized enterprises
SMR	Steam methane reforming
SOE	State-owned enterprise
SOEC	Solid oxide electrolysis cell
UAN	Urea ammonium nitrate
VAT	Value-added tax
WACC	Weighted average cost of capital



ENERGY SOLUTIONS – MADE IN GERMANY

The German Energy Solutions Initiative

The German Energy Solutions Initiative of the German Federal Ministry for Economic Affairs and Energy (BMWE) aims to globalise German technologies and expertise in climate-friendly energy solutions.

Years of promoting smart and sustainable energy solutions in Germany have led to a thriving industry known for world-class technologies. Thousands of specialised small and medium-sized enterprises (SMEs) focus on developing renewable energy systems, energy efficiency solutions, smart grids, and storage technologies. Cutting-edge energy solutions are also built on emerging technologies such as power-to-gas, fuel cells, and green hydrogen. The initiative's strategy is shaped around ongoing collaboration with the German business community.

The initiative creates benefits for Germany and the partner countries by:

- boosting global interest in sustainable energy solutions
- encouraging the use of renewables, energy efficiency technologies, smart grids, and storage technologies, while facilitating knowledge exchange and capacity building
- enhancing economic, technical and business cooperation between Germany and partner countries

THE PROJECT DEVELOPMENT PROGRAMME (PDP)

PDP is a key pillar of the German Energy Solutions Initiative and is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. It connects development cooperation with private-sector engagement and supports climate-friendly energy solutions in selected developing and emerging countries, enabling local businesses to adopt solutions in energy efficiency, electricity and heat supply, and hydrogen, while facilitating market access for German solution providers.

Developing and emerging economies offer promising business potential for climate-friendly energy solutions but also pose challenges for international business partners. The PDP team works closely with local industries to develop financially viable projects by providing technical expertise, financial guidance, and networking opportunities.

It identifies project leads, collects and analyses energy consumption data, and assesses projects from both a technical and economic perspective. This includes outlining the business case, calculating payback periods, and evaluating profitability. Companies can then choose to finance projects using their own funds or explore leasing and other financing options. PDP provides cost-free advice to local companies and connects them with German solution providers for project implementation.

Additionally, by offering training, organising reference project visits, and publishing studies on the potential of climate-friendly solutions and on navigating regulatory frameworks, the programme supports market development and fosters private-sector cooperation.

Executive summary

GREEN HYDROGEN FOR INDONESIA'S C&I SECTOR

The H_2 Sector Analysis for Indonesia assesses the potential for green hydrogen development in the country, providing a foundation for future projects. This study is part of a series to offer market insights and support pre-development efforts to generate both local and international interest in the green hydrogen economy.

The analysis explores the feasibility of introducing green hydrogen into Indonesia's commercial and industrial sectors, evaluating specific use cases and providing techno-economic estimates for stakeholders – particularly companies based in Germany. The objective is to identify viable opportunities, address key challenges, and outline a pathway for green hydrogen integration that aligns with Indonesia's broader energy and industrial development goals.

Indonesia, the largest economy in Southeast Asia, offers a significant potential market for green hydrogen applications. The country has vast renewable energy resources, particularly geothermal and solar photovoltaic (PV), which could support hydrogen production via electrolysis. Indonesia's geographic position, its strong industrial base, and its status as a major maritime trade hub enhance its long-term potential for both domestic green hydrogen use and exports.

Zusammenfassung

GRÜNER WASSERSTOFF FÜR DEN GEWERBE- & INDUSTRIE-SEKTOR INDONESIENS

In der H_2-Sektoranalyse für Indonesien wird das Potenzial der Entwicklung grünen Wasserstoffs in Indonesien bewertet, um eine Grundlage für zukünftige Projekte zu bieten. Die Sektoranalyse ist Teil einer Reihe von Analysen, die Markteinblicke bieten sowie Vorentwicklungsprozesse unterstützen und so sowohl das lokale als auch das internationale Interesse an einer grünen Wasserstoffwirtschaft wecken.

In dieser Sektoranalyse wird die Machbarkeit der Einführung grünen Wasserstoffs in Indonesiens Gewerbe- und Industriesektor untersucht, zudem werden Anwendungsfälle bewertet und techno-ökonomische Einschätzungen für relevante Akteure – insbesondere für in Deutschland ansässige Unternehmen – geliefert. Ziel ist es, tragfähige Chancen zu identifizieren, zentrale Herausforderungen aufzuzeigen und einen Fahrplan für die Integration grünen Wasserstoffs zu skizzieren, der mit Indonesiens übergeordneten Energie- und Industrieentwicklungszielen in Einklang steht.

Indonesien, die größte Volkswirtschaft Südostasiens, bietet einen vielversprechenden Markt für Anwendungen mit grünem Wasserstoff. Das Land verfügt über umfangreiche Quellen für erneuerbare Energien, insbesondere für Geothermie und Photovoltaik, die eine Wasserstoffproduktion per Elektrolyse ermöglichen könnten. Indonesiens geografische Lage, seine starke industrielle Basis und seine Bedeutung als maritimer Handelsknotenpunkt stärken das langfristige Potenzial für die Nutzung grünen Wasserstoff im Inland und für den Export.

Green hydrogen could play a complementary role in Indonesia's energy transition by:

- **Supporting industrial decarbonization:** Key industries such as ammonia and fertilizer production, steel manufacturing, and petrochemicals could integrate hydrogen into their processes to reduce carbon emissions.
- **Leveraging renewable energy potential:** Indonesia has one of the world's largest geothermal energy reserves, alongside strong solar potential, which can provide a reliable and sustainable energy source for hydrogen production.
- **Strengthening energy security:** Hydrogen can help diversify Indonesia's energy mix, reducing dependence on imported fuels while enhancing energy resilience.
- **Export opportunities:** With its strategic position between key global trade routes, Indonesia could develop into a regional hub for hydrogen exports, particularly to Asian markets like Japan and South Korea.

BUSINESS OPPORTUNITIES FOR GERMAN SOLUTION PROVIDERS

Indonesia's evolving energy landscape presents several business opportunities for German solution providers, particularly in renewable energy, electrolysis, industrial applications, and infrastructure development. Key advantages include:

- **Renewable energy potential:** Indonesia's vast geothermal and solar resources provide a strong foundation for green hydrogen production. German firms specializing in electrolysis, hydrogen storage, and renewable energy integration can play a crucial role in early-stage projects.

Grüner Wasserstoff kann Indonesiens Energiewende ergänzen, indem er

- **zur Dekarbonisierung der Industrie beiträgt:** Zentrale Branchen wie die Ammoniak- und Düngemittelproduktion, die Stahlherstellung und die Petrochemie könnten Wasserstoff in ihre Prozesse integrieren und so CO_2-Emissionen senken.
- **das Potenzial erneuerbarer Energien nutzt:** Indonesien verfügt über eines der weltweit größten Geothermievorkommen sowie über ein hohes Potenzial für Solarenergie. Das ist eine verlässliche und nachhaltige Grundlage für die Wasserstoffproduktion.
- **die Energiesicherheit stärkt:** Wasserstoff kann zur Diversifizierung des Energiemixes beitragen, die Abhängigkeit von importierten Brennstoffen verringern und die Widerstandsfähigkeit der Energieversorgung erhöhen.
- **Exportmöglichkeiten eröffnet:** Aufgrund seiner strategischen Lage – Indonesien liegt an wichtigen globalen Handelsrouten – könnte sich das Land zu einem regionalen Exportzentrum für Wasserstoff entwickeln, insbesondere mit Blick auf asiatische Märkte wie Japan und Südkorea.

GESCHÄFTSMÖGLICHKEITEN FÜR DEUTSCHE LÖSUNGSANBIETER

Die sich wandelnde Energielandschaft Indonesiens eröffnet deutschen Lösungsanbietern Geschäftsmöglichkeiten, insbesondere in den Bereichen erneuerbare Energien, Elektrolyse, industrielle Anwendungen und Infrastrukturentwicklung. Zentrale Vorteile sind

- **das Potenzial für erneuerbare Energien:** Indonesiens umfangreiche Geothermie- und Solarpotenziale bilden eine solide Grundlage für die Produktion grünen Wasserstoffs. Deutsche Unternehmen mit

- **Industrial integration:** Indonesia has a large, diversified industrial base, with strong demand for hydrogen in sectors such as refining, chemicals, and steel. German companies with expertise in industrial hydrogen applications can support pilot projects and large-scale deployment.
- **Export and trade potential:** As a major economy and trade hub, Indonesia could become a key player in hydrogen exports. German businesses involved in port infrastructure, hydrogen transportation, and supply chain logistics could benefit from early engagement.

CHALLENGES ON THE PATH TO A HYDROGEN ECONOMY

Despite its potential, Indonesia faces several hurdles in developing a green hydrogen economy:

- **Cheap domestic fossil fuels:** The availability of low-cost natural gas and coal could delay the transition to green hydrogen, as existing industries remain reliant on conventional energy sources.
- **Infrastructure gaps:** While Indonesia has a well-developed energy sector, additional investment is required to develop hydrogen production, storage, and transportation infrastructure, which might turn out challenging considering the archipelagic nature of the country.
- **Regulatory uncertainty:** Indonesia's energy policies are evolving, and a clear regulatory framework for hydrogen development is still in progress. German companies will need to navigate policy risks while engaging in long-term investment planning.
- **Economic feasibility:** The high cost of green hydrogen production, compared to traditional energy sources, remains a barrier. German firms can play a role in cost reduction through technology innovation, investment partnerships, and policy advocacy.

Spezialisierung auf Elektrolyse, Wasserstoffspeicherung und die Integration erneuerbarer Energien können eine Schlüsselrolle in frühen Projektphasen einnehmen.

- **die industrielle Integration:** Indonesien verfügt über eine große und diversifizierte Industrie mit hohem Wasserstoffbedarf in Sektoren wie dem der Raffinerien, der Chemie und des Stahls. Deutsche Unternehmen mit Erfahrung in industriellen Wasserstoffanwendungen können Pilotprojekte unterstützen und den Markthochlauf begleiten.
- **die Export- und Handelschancen:** Als bedeutende Wirtschaftsnation und Handelsdrehscheibe könnte Indonesien eine zentrale Rolle im Wasserstoffexport einnehmen. Deutsche Firmen aus der Hafeninfrastruktur, dem Wasserstofftransport und der Logistik können von einem frühzeitigen Engagement profitieren.

HERAUSFORDERUNGEN AUF DEM WEG ZUR WASSERSTOFFWIRTSCHAFT

Trotz seines Potenzials steht Indonesien vor mehreren Herausforderungen beim Aufbau einer grünen Wasserstoffwirtschaft:

- **günstige fossile Brennstoffe im Inland:** Die Verfügbarkeit von preiswertem Erdgas und Kohle könnte den Übergang zu grünem Wasserstoff verzögern, weil die Industrie weiterhin auf konventionelle Energiequellen setzen.
- **Infrastrukturlücken:** Obwohl Indonesien über einen gut entwickelten Energiesektor verfügt, sind zusätzliche Investitionen dafür notwendig, eine Infrastruktur für die Wasserstoffproduktion, -speicherung und -verteilung aufzubauen. Die geografische Zergliederung des Landes erschwert diese Entwicklung zusätzlich.

WHY INDONESIA MATTERS FOR GREEN HYDROGEN

Indonesia's strong industrial base, renewable energy resources, and strategic location create a promising landscape for green hydrogen development. However, challenges such as cheap domestic fossil fuels, infrastructure limitations, and regulatory uncertainties must be addressed. German companies that position themselves early can contribute to shaping this emerging market while benefiting from Indonesia's long-term energy transition and industrial modernization. Through targeted investments, innovation, and policy engagement, German firms can play a crucial role in Indonesia's future hydrogen economy.

- **regulatorische Unsicherheiten:** Indonesiens Energiepolitik befindet sich im Wandel; ein klarer regulatorischer Rahmen für die Wasserstoffentwicklung ist noch in Arbeit. Deutsche Unternehmen müssen bei langfristigen Investitionen politische Risiken einkalkulieren.
- **wirtschaftliche Machbarkeit:** Die derzeit hohen Kosten für die Produktion grünen Wasserstoffs im Vergleich zu konventionellen Energieträgern stellen eine Hürde dar. Deutsche Unternehmen können durch technologische Innovationen, Investitionspartnerschaften und politische Beratung zur Kostensenkung beitragen.

WARUM INDONESIEN FÜR GRÜNEN WASSERSTOFF RELEVANT IST

Indonesiens starke industrielle Basis, umfangreiche Quellen für erneuerbare Energie und die strategische Lage des Landes sind ein vielversprechendes Umfeld für die Entwicklung grünen Wasserstoffs. Gleichzeitig gilt es, Herausforderungen wie die der günstigen fossilen Brennstoffe im Inland, infrastrukturelle Defizite und regulatorische Unsicherheiten zu überwinden. Deutsche Unternehmen, die sich frühzeitig positionieren, können zur Gestaltung dieses entstehenden Marktes beitragen und gleichzeitig von Indonesiens langfristiger Energiewende und industrieller Modernisierung profitieren. Durch gezielte Investitionen, Innovationen und politische Mitgestaltung können deutsche Firmen eine Schlüsselrolle in der zukünftigen Wasserstoffwirtschaft Indonesiens spielen.

1

Outline of the current context

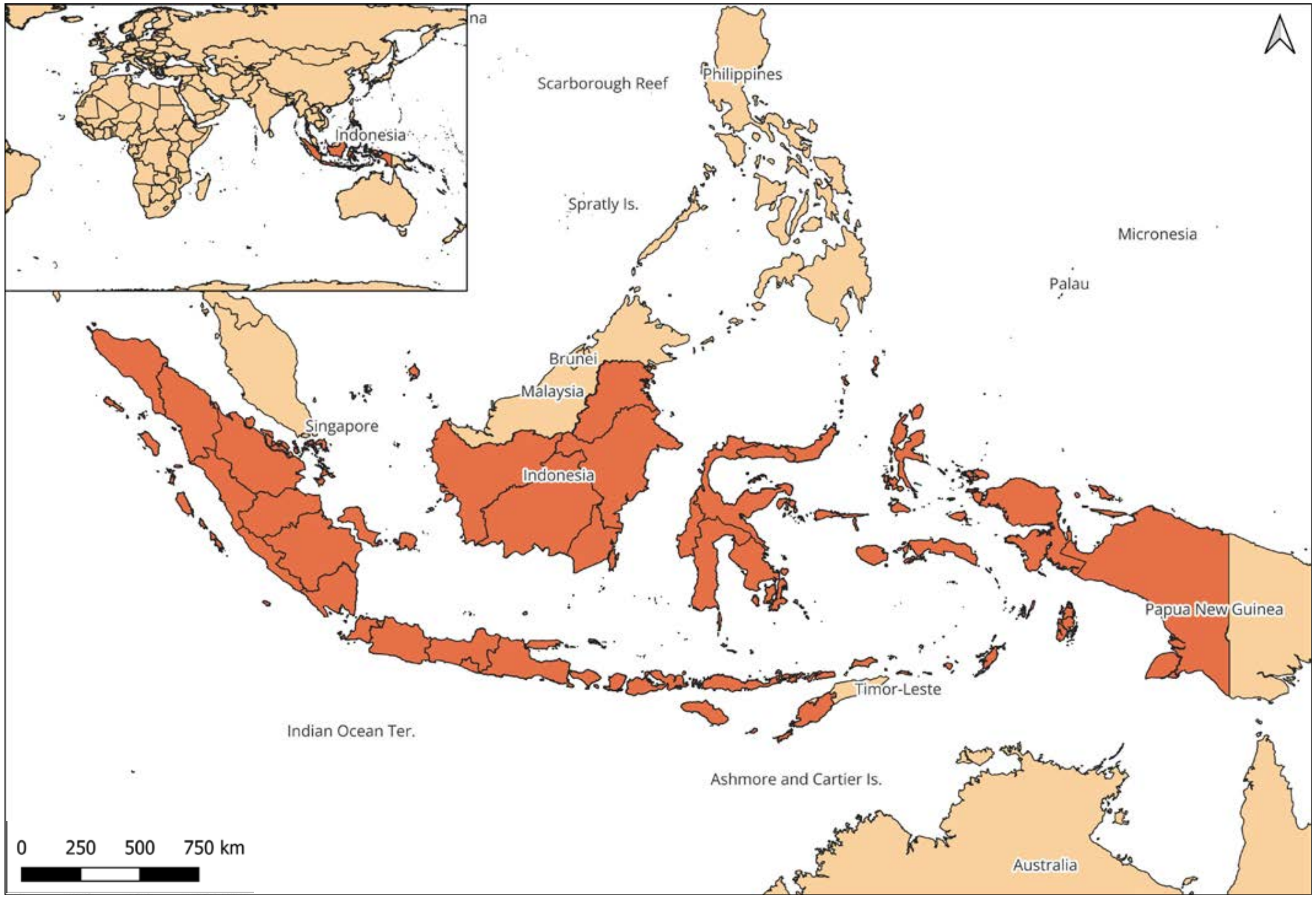
1.1 General country information

Indonesia is the largest archipelagic nation. It spans over 17,000 islands, covering approximately 1.9 million km². The country has a population of about 279 million as of 2023 (Ministry of Energy and Mineral Resources, 2024). Indonesia has the largest economy in Southeast Asia, heavily reliant on natural resources such as crude oil, natural gas, coal, and palm oil. Indonesia's GDP reached USD 1.4 trillion in 2023, equating to USD 4,940 per capita. In 2022, all urban citizens and 98% of the rural population had access to electricity (World Bank, 2024a).

As shown in (OEC, 2025), Indonesia's economy depends on exporting mineral fuels, mineral oils and oil products (24.4%), animal or vegetable fats, oils & waxes (14%), iron & steel (9%), and electrical machinery & electronics (5.5%). From an import perspective, machinery, mechanical appliances & parts, electrical machinery & electronics (together 24.1%), mineral fuels, mineral oils & products of their distillation (18.5%), and iron & steel (5.2%) are the main imported goods. The fact that the mineral fuels, mineral oils and products of their distillation sector is both a major exporter and importer reflects the fact that Indonesia exports large quantities of coal while it imports large quantities of refined oil products. In 2022, the total export and import volumes reached USD 320 billion and USD 230 billion respectively.

Considering national GDP in 2023, manufacturing contributed around 19%, wholesale and retail trade some 13%, and agriculture (including fishery) around 12% (BPS, 2023). Combined, the mining and energy sectors (including exports of coal, oil, and gas) contributed approximately 6% to Indonesia's GDP.

FIGURE 1. Location of Indonesia



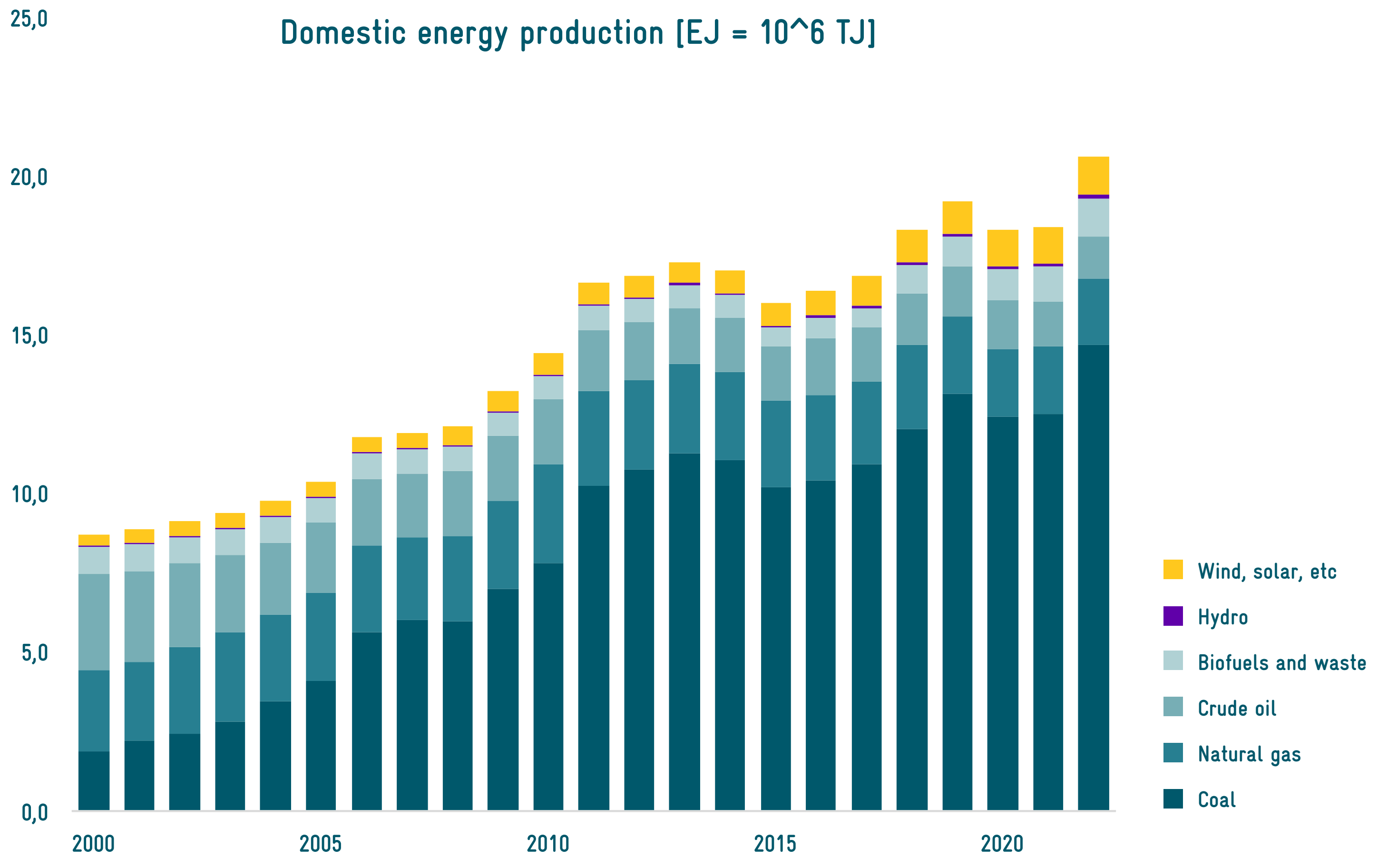
Source: Authors' own compilation, Fichtner (2024) based on (OpenStreetMap, 2024)

1.2 National energy sector analysis

1.2.1 Evolution of the energy sector to the present

Figure 2 shows the evolution of Indonesia's energy production, with fossil fuels being the major sources (in exajoules, EJ = 10^6 terajoules, TJ). Energy production includes any exploration of fossil fuels, which can be burned to produce electricity or heat, or used directly as fuel, for example. It also includes energy produced by nuclear fission and renewable energy sources, such as biomass, solar PV, wind, geothermal, and hydropower. In Indonesia, energy production is highly dominated by coal. Domestic production of coal almost doubled from 2010 to 2022, accounting for 71% of total domestic energy production in 2022. Natural gas also plays an important role, with 10% of Indonesia's energy production in 2022, but domestic production saw a reduction of about 34% compared to 2010. Domestic crude oil production declined by 35% from 2010 to 2022 due to ageing oil fields and the lack of new oil field exploration, but it still represents some 6% of Indonesia's energy production. On the other hand, domestic production of renewable energy such as hydro, solar, wind, and biofuels rose by 70% from 2010 to 2022, and together represented around 12% of Indonesia's energy production in 2022.

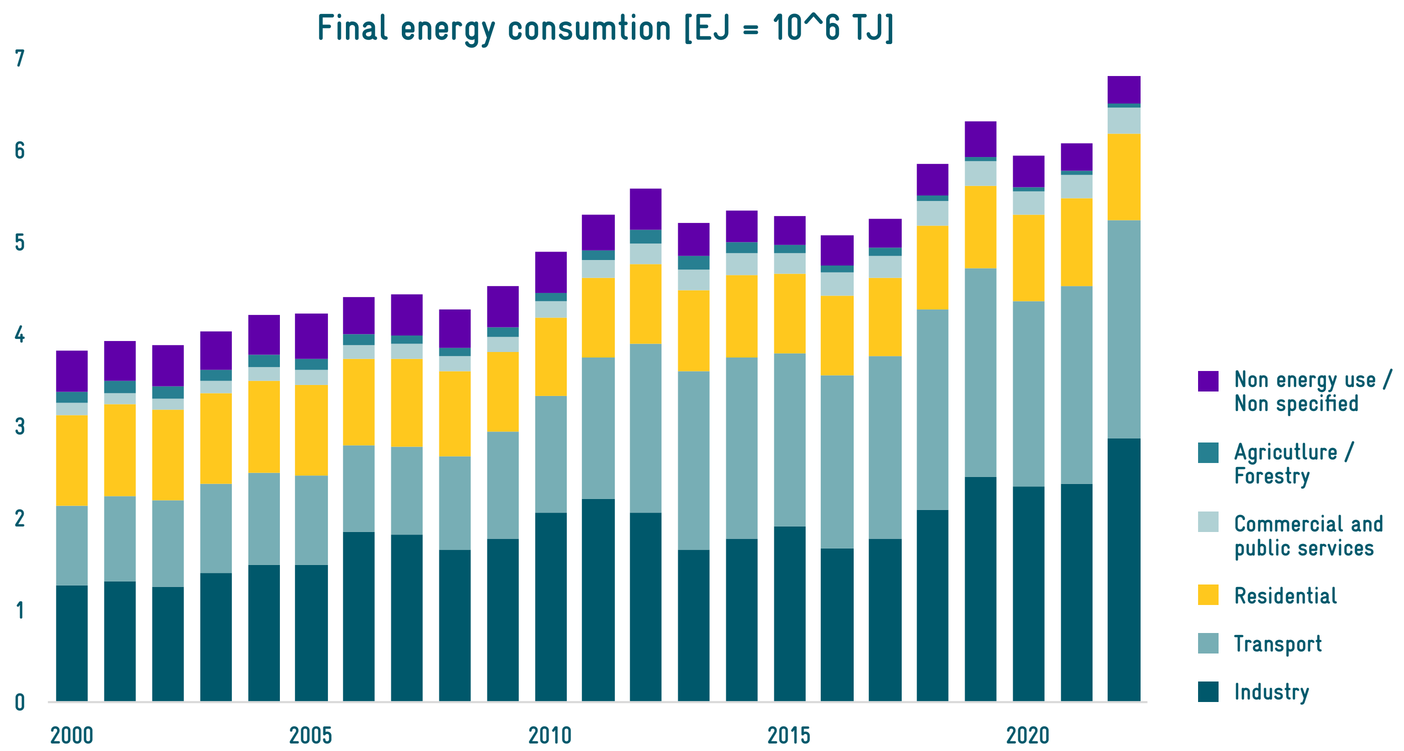
FIGURE 2. Evolution of domestic energy production in Indonesia since 2000 (in EJ)



Source: Authors' own compilation, Fichtner (2025) based on (IEA, 2024a)

Regarding final energy consumption, Figure 3 shows that it has increased by almost 78% since 2000, reaching about 6.8 EJ in 2022, with industry and transport as the main consumption sectors, representing 42% and 35% each. The residential sector accounts for 14% of final energy consumption and remains at a relatively constant level overall; this reflects a drastic reduction in traditional biomass and kerosene consumption by almost 70% since 2013 and an increase in biogas and electricity consumption by 84% and 28%, respectively, since 2015 (Ministry of Energy and Mineral Resources, 2024). Other sectors include commercial and public services, agriculture and forestry, and non-specified or non-energy use; together they make up 9% of final energy consumption.

FIGURE 3. Evolution of final energy consumption by sector in Indonesia since 2000 (in EJ)



Source: Authors' own compilation, Fichtner (2025) based on (IEA, 2024a)

Energy prices

Indicative current energy prices for the main energy sources are listed in Table 1, complemented by prices for Indonesia's Emission Trading Scheme (ETS). The prices serve merely as an initial indication of current levels since there are regional variations across the country and over time, and for coal also in relation to the quality (calorific value). Energy prices are regulated in Indonesia. Coal prices are subject to regulation through a domestic market obligation (DMO) mechanism, according to which coal producers are required to sell a portion to the domestic market at regulated prices (especially to the state-owned company Perusahann Listrik Negara, PLN) and with a monthly coal benchmark price (Harga Batubara Acuan) as a reference price for coal sales other than DMO. Natural gas prices are regulated, and include caps on prices for key sectors (listed as prioritised industries in the table, which include seven sectors: fertiliser, petrochemical, steel, ceramic, glass, oleochemical, and rubber). Electricity tariffs are regulated by the Ministry of Energy and Mineral Resources and provided by PLN.

TABLE 1. Indicative energy prices for Indonesia

Energy source		Price [th IDR]	Price [USD]	Unit	Date
Coal	FOB export	3,176	201.1	/ t	2023
	HBA, 4 categories: lowest to highest calorific value	561	19.1 42.0	/ MWh / MWh	July 2024
Crude oil	Average Indonesian crude price (57 types)	min. 1,125 max. 1,363 1,235	min. 71.4 max. 86.5 78.4	/ bbl / bbl / bbl	2023
Natural gas	Households	296	18.8	/ MWh	2022
	Prioritised industries	323	20.5	/ MWh	2024
	Industrial & commercial	409	25.9	/ MWh	2022
	LNG (export)	564	35.8	/ MWh	2023
Electricity	Household	1,179	74.8	/ MWh	2023
	Commercial	1,284	81.5	/ MWh	2023
	Industry	1,102	69.9	/ MWh	2023
ETS/CO_2	ETS	9.5	0.6	/ t_{CO_2}	2024

t	metric tonne
bbl	barrels

Source: Authors' own compilation, Fichtner (2025) based on: Coal, Crude Oil, Electricity (Ministry of Energy and Mineral Resources, 2024), Coal HBA (Orient, 2024), Natural gas (LDI Training, 2023), ETS (World Bank, 2024b)

1.2.2 Forecasted evolution of the energy sector

In 2022 Indonesia published its Enhanced Nationally Determined Contribution (Republic of Indonesia, 2022), in which the country committed to a greenhouse gas (GHG) emissions reduction target of 31.9% unconditionally and 43.2% conditionally. In order to achieve these targets, the document establishes actions to be taken by the energy sector, including on renewable energy, energy efficiency, low carbon emitting fuels, clean coal technology, and gas power plant and post-mine reclamation.

As far as renewable energy is concerned, the country aims to reach an installed capacity of 36 GW by 2030, including geothermal, hydropower, solar PV, and wind. Additional targets are defined for biomass, biogas, and biofuel, which will play a relevant role in rural and off-grid areas in particular. Given its extensive archipelagic geography, Indonesia is also exploring the feasibility of marine and tidal energy.

Energy efficiency-related actions aim to increase the electrification of end uses (e.g. cooking with electric induction stoves, e-mobility) and correspondingly reduce the use of fossil fuels. Other measures that are expected to reduce emissions from fossil fuel are the use of compressed natural gas for public transport and the implementation of clean coal technology and gas power plants with a capacity up to 27.5 GW (without mandatory use of carbon capture technology).

Indonesia's electricity consumption is projected to increase by between 5% and 6% annually up to 2030. To meet the Paris Agreement targets, Indonesia would need to double its renewable energy target (currently set at 23% by 2025, to 45% by 2030) and phase out coal by 2040 (Climate Transparency, 2024). The share of electricity generation from renewable energy sources has been on average around 18% in the last five years, so a significant increase is required in the coming years in order to be able to achieve the set goals. This might be challenging considering the timeline and stagnated investments in the sector in recent years (Institute for Energy Economics and Financial Analysis, 2024).

1.3 Legislative and regulatory framework

Indonesia's legislative and regulatory framework surrounding renewable energy, climate change, and emerging sectors such as GH_2 has been evolving, particularly in response to global climate commitments and national energy needs. Key national laws and regulations that guide Indonesia's energy transition are outlined in the following.

Energy Law (Law No. 30 of 2007) (Ministry of Energy and Mineral Resources, 2007)

OVERVIEW:

This serves as the foundational framework for renewable energy development in Indonesia and outlines the government's commitment to increasing the share of renewables in the national energy mix, particularly through the development of solar photovoltaics (PV), wind, geothermal, and biomass energy.

KEY PROVISIONS:

- **Renewable energy targets:** Indonesia aims to obtain 23% of its energy mix from renewable sources by 2025.
- **Fiscal incentives:** Various incentives, including tax exemptions for renewable energy investments and import duty exemptions on renewable energy equipment.
- **Feed-in tariffs (FiTs):** Proposal of guaranteed fixed payments for renewable electricity which has not been happening as of now.
- **Financing mechanisms:** Subsidies may be provided by the government as well as access to soft loans or credit facilities from state-owned banks for renewable energy investments.
- **Permitting:** Process simplification to speed up project implementation in renewable energies.

Law on Environmental Protection and Management (Law No. 32/2009) (Ministry of Environment and Forestry, 2009)

OVERVIEW:

This law provides the legal framework for environmental governance and establishes principles for sustainable development. It aims to promote environmental conservation and the sustainable management of natural resources, and to address environmental degradation.

KEY PROVISIONS:

- **Climate change mitigation:** Requires the government to develop and implement strategies, policies, and programmes to mitigate GHG emissions and adapt to climate change impacts. Indonesia targets a 29% reduction in GHG emissions by 2030, with potential to increase this to 41% with international support.
- **Environmental Impact Assessment (EIA):** Mandates an EIA for projects that may significantly impact the environment, ensuring identification and mitigation of potential negative effects.
- **Environmental protection agency:** Establishes the roles of governmental bodies at national and local levels responsible for implementing and monitoring environmental protection measures.
- **National action plan:** Establishes a National Action Plan on Climate Change Adaptation (RAN-API) and Mitigation (RAN-GRK) aimed at reducing GHG emissions.

National Energy Policy (Regulation No. 79 of 2014) (Indonesia, 2014)

OVERVIEW:

It outlines the framework for the country's energy management and development, emphasising the importance of achieving energy security through the diversification of energy sources and ensuring reliable supply for domestic and industrial needs.

KEY PROVISIONS:

- **Renewable energy development:** It sets targets for increasing the use of renewable energy in the national energy mix, aiming for at least 23% of the total energy supply to come from renewables by 2025.
- **Energy efficiency:** The policy promotes energy efficiency and conservation as essential components to reduce consumption and environmental impact.
- **Sustainable development:** Emphasises sustainable energy practices to minimise environmental degradation and support economic growth.
- **Access to energy:** The regulation aims to enhance energy access, particularly for rural and underserved areas, ensuring that all citizens have access to affordable and reliable energy.
- **Regulatory framework:** It establishes a regulatory framework for energy management, encouraging collaboration among government agencies, private sector stakeholders, and communities.
- **Investment climate:** The policy aims to create a conducive investment climate for energy infrastructure and technology, including incentives for renewable energy projects.

Presidential Regulation No. 22 of 2017 (Ministry of Energy and Mineral Resoruces, 2017)

Overview:

It sets out the General Plan for National Energy (RUEN) and serves as a long-term framework guiding the country's energy policies from 2017 to 2050.

Key provisions:

- **Energy mix targets:** The regulation sets different targets for energy sources, including: 23% by 2025 and 31% by 2050 for renewable energy, around 30% for coal by 2025 (25% by 2050), and 20% for oil by 2050.
- **Promotion of renewable energy:** The RUEN includes incentives, regulatory support, and private sector engagement to boost renewables, with a priority on geothermal resources.
- **Electrification:** Targets 100% electrification by 2025, especially in remote areas.
- **Clean coal technology and gas:** Supports cleaner coal technologies (such as supercritical plants) and positions natural gas as a bridge fuel, with infrastructure development for gas pipelines and LNG facilities.
- **Nuclear and new energy sources:** Nuclear energy and new sources such as hydrogen and biofuels are explored for future diversification.
- **Infrastructure development:** The regulation calls for investment in energy infrastructure, including power plants and transmission lines, for both urban and rural energy distribution.

National Medium-Term Development Plan 2020-2024 (RDMP/RPJMN) (Ministry of National Development Planning / National Development Planning Agency, 2020)

Overview:

The RPJMN is a strategic planning document that guides Indonesia's economic and social development over a five-year period. It includes targets and strategies related to renewable energy, energy security, and climate change mitigation. The document aligns with and is complemented by the General Plan for National Energy (RUEN) (Presidential Regulation No. 22 of 2017).

Key provisions:

- **Renewable energy:** The RPJMN aims at achieving 23% renewable energy in the national energy mix by 2025, with an installed capacity of approximately 45 GW by 2024.

- **Rural electrification:** The aim is to achieve universal access to electricity by expanding off-grid renewable energy systems in remote and underserved areas.
- **Energy efficiency:** The plan encourages energy efficiency measures and the adoption of cleaner technologies in various sectors, including industry, transportation, and buildings.

Indonesia's Nationally Determined Contribution (NDC) (Ministry of Environment and Forestry, 2020)

Overview:

Indonesia's updated NDC under the Paris Agreement articulates the country's climate goals, emphasising both mitigation and adaptation strategies

Key provisions:

- **GHG emissions target:** Commitment to reduce GHG emissions by 29% unconditionally and by 41% conditionally by 2030 compared to business-as-usual scenarios.
- **Sectoral focus:** Identifies priority sectors for emissions reduction, including energy, forestry, and agriculture.

Carbon Pricing Mechanism (Regulation No. 98 of 2021) (Ministry of Finance, 2021)

Overview:

Implements carbon pricing as part of Indonesia's commitment to reducing emissions. It establishes a framework for carbon trading and tax mechanisms and targets industries and sectors with significant emissions, particularly fossil fuel-based industries.

Key provisions:

- **Carbon tax:** Applies to multiple sectors, including energy, waste, industrial processes, agriculture, and forestry, based on their emissions levels, encouraging emissions reductions and investment in cleaner technologies. The carbon tax rate was set at approximately USD 2 (IDR 30,000) per tonne of CO_2.
- **Revenue allocation:** Funds generated from the carbon tax will support renewable energy projects and climate resilience initiatives.

Accelerated Development of Renewable Energy for Electricity Supply (Presidential Regulation No. 112 of 2022) (Indonesia, 2022)

Overview:

The regulation provides a framework for sustainable energy transition, integrating renewable sources, promoting energy efficiency, and encouraging technological innovation.

Key provisions:

- **Electricity purchases** are prioritised from renewable sources.
- **Procurement processes** for renewable energy are streamlined.
- **Roadmap for phasing out coal-fired power plants.** New coal-fired plants are banned unless previously planned or deemed strategically important with a commitment to cease operations by 2050.
- The government can provide **incentives** for renewable energy projects.

Law No. 3 of 2022 on the National Strategic Projects (Kementeriann PPN, 2022)

Overview:

This law aims to accelerate the implementation of key infrastructure and development projects that are deemed vital for the nation's economic growth and social welfare. It focuses on simplifying regulatory processes, providing incentives, and ensuring efficient project execution.

Key provisions:

- **Establishes a list of National Strategic Projects** (NSPs) that will receive priority and expedited approvals.
- **Introduces a more streamlined licensing process** for these projects to reduce bureaucratic delays.
- **Offers incentives** such as tax breaks and land acquisition support for NSPs.
- **Involves both public and private sectors in the financing and execution** of NSPs.
- **Ensures** that **environmental and social impacts** of NSPs are carefully managed, with a focus on sustainability.

National Hydrogen Strategy (2023) (Ministry of Energy and Mineral Resources, 2023)

Overview:

Launched in 2023, this strategy aims to position Indonesia as a key player in the global hydrogen economy, capitalising on its renewable energy potential.

Key provisions:

- **Hydrogen production goals:** Targeting low-carbon hydrogen production of up to 1 million tonnes annually (MTPA) by 2030 to supply the domestic market and expansions beyond 2030 to include exports.
- **Infrastructure development:** Plans to invest in electrolysers, transportation, and storage facilities to support hydrogen production and distribution.
- **International cooperation:** Encourages partnerships with other nations to facilitate technology transfer and investment in hydrogen projects.

National Hydrogen and Ammonia Roadmap (2025) (Ministry of Energy and Mineral Resources, 2025)

Overview:

Launched in April 2025, this roadmap aims to support the achievement of Indonesia's net-zero emissions target by 2060 through a comprehensive energy transition and decarbonisation, building on the National Hydrogen Strategy introduced in 2023.

Key provisions:

- **Strategic goals:** Decarbonisation of the energy sector by integrating low-carbon hydrogen and ammonia into energy systems, developing a domestic hydrogen and ammonia industry with a competitive and sustainable national value chain, diversifying energy sources to reduce dependence on fossil fuels, and positioning Indonesia as a major hydrogen and ammonia exporter in Asia-Pacific.
- **Implementation phases:** The roadmap outlines three progressive stages: initial phase (2025–2034), development and integration (2035–2045), and acceleration and sustainability (2046–2060).

- **Sectoral applications:** In transportation (hydrogen for FCEV, ammonia for maritime fuel), industry (replacement of fossil fuels in steel, cement, ceramics, and chemicals, and use of ammonia as feedstock and fuel) and power generation (ammonia co-firing in coal power plants, hydrogen and ammonia gas turbines).
- **Export opportunities:** Focus on Japan, South Korea, and the European Union as priority markets, promoting Indonesia's hydrogen and ammonia potential from solar, hydropower, and geothermal.

Indonesia's legislative and regulatory framework generally aims at supporting the development and expansion of renewable energy sources, energy efficiency measures, and climate change mitigation efforts. The government has set renewable energy targets and implemented policies to attract investments, promote clean energy deployment, and reduce GHG emissions. The current government has focused on infrastructure development and economic growth, creating a more favourable environment for foreign investment. Nonetheless, it has to be highlighted that the implementation of renewable energy projects still faces major challenges that include cost and risk factors, market structure, the role of PLN, and policy uncertainty (Chen, K. et all, 2022). Mainly decentralised renewable energy projects are considered unattractive due to high regulatory constraints (CPI, 2020); for example, the role of PLN as single buyer in the Indonesian electricity market reduces the competitiveness of the projects (Chen, K. et all, 2022). CO_2

2

Industrial applications of hydrogen

2.1 The hydrogen industry in Indonesia

2.1.1 Overview of the national industry

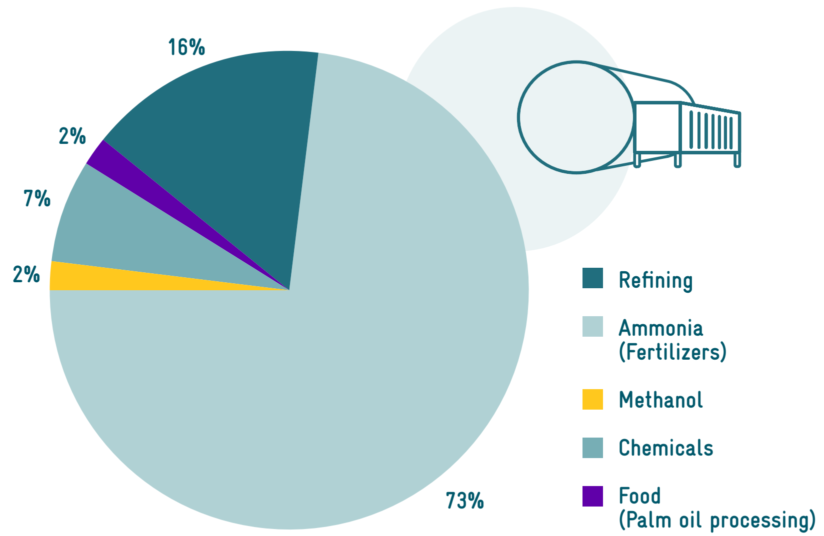
The hydrogen industry in Indonesia is mainly concentrated in ammonia production (for fertilisers), refining, methanol, and the chemical sector. On-site production is dominated by state-owned players and based mainly on natural gas.

Since hydrogen is typically produced on site, no hydrogen trading takes place (or only on a small scale). Regarding the main hydrogen derivatives, Indonesia exported 1.8 MTPA of ammonia in 2023 and imported 1 MTPA of methanol. Comparatively small volumes of other derivatives (e.g. chemicals such as cyclohexane) have been imported.

Hydrogen statistics are not available for Indonesia, but some estimates have been published mentioning total hydrogen demand of approximately 1.74 MTPA in 2021 (IEA, 2022), (ERIA, 2024). In these circumstances, in order to obtain an overview of Indonesia's hydrogen industry, current hydrogen demand for large consumers is estimated based on either known production capacities, specific hydrogen demand ratios, and an assumption that plants operate at full load, or in reference to estimates published in (ERIA, 2024). The results of these estimations are shown in Figure 4 and Table 2. Further details are provided in the following sections.

The estimates of hydrogen demand for the largest consumers result in local hydrogen demand of approximately 1.73 MTPA. This demand is likely to increase in the future, for instance following the commissioning of new methanol plants that are currently planned. Demand in small consumer sectors was not considered, but total hydrogen demand in the country will remain within the estimated order of magnitude as it is mostly determined by the large consumers.

FIGURE 4. Estimated local hydrogen demand in Indonesia



Source: Authors' own compilation, Fichtner (2025)

TABLE 2. Estimated local hydrogen demand for main sectors

Product	Specific H_2 demand [t_{H2}/t product]	Local capacity [MTPA]	Potential H_2 demand [kTPA]
Petroleum refining	0.005	51.3	279
Fertilisers (various)	For NH_3: 0.177	7.1	1,260
Chemicals (various)	Various		32
Methanol	0.189	0.66	125
Food (various)	0.005*	6.67	34
Total	–	–	1,729

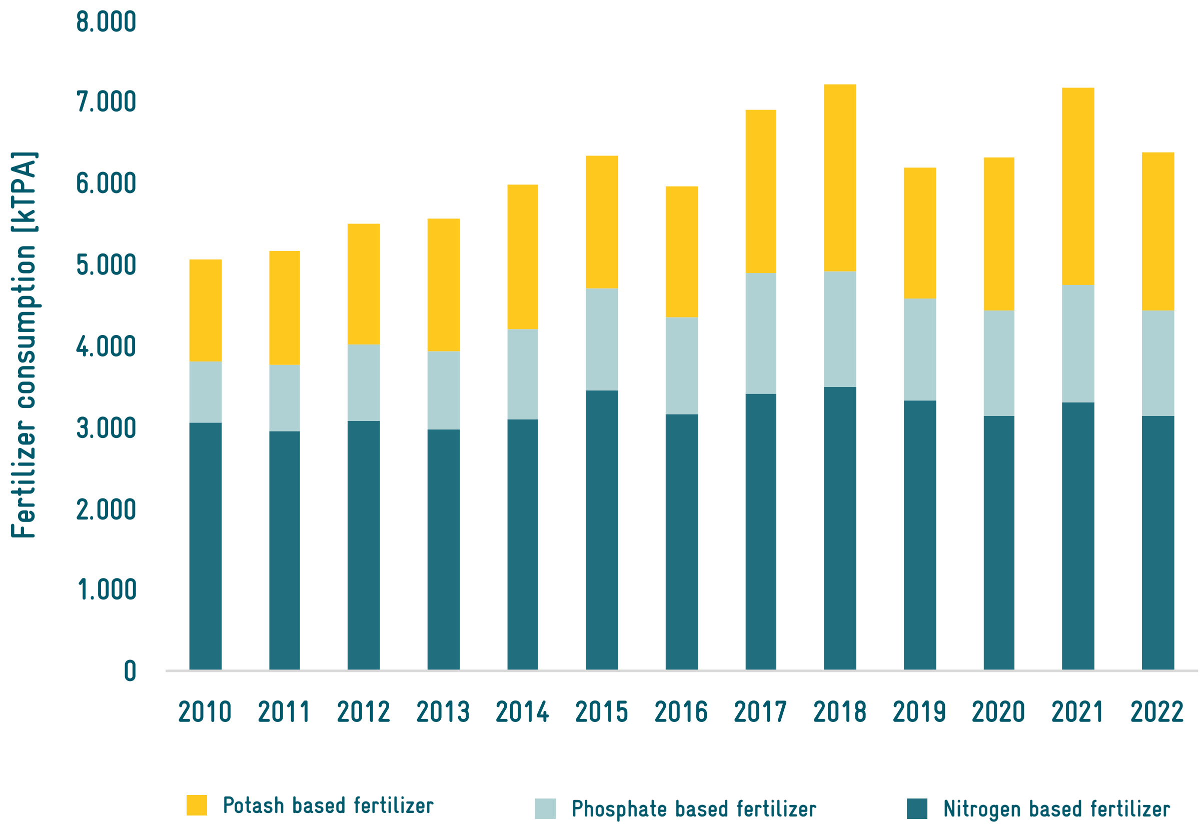
Source: Authors' own compilation, Fichtner (2025)

* Assuming refining of palm oil to margarine

2.1.2 The fertiliser industry

Fertiliser production in Indonesia is dominated by the public sector and focuses on urea-based fertilisers, while more complex fertilisers are imported in large quantities (AHK Indonesia, 2025), making the country one of the largest fertiliser importers in the world. Figure 5 shows the evolution of consumption of nitrogen-based (~50%), phosphate-based (~30%), and potash-based (~20%) fertilisers in Indonesia since 2010. Fertiliser consumption has fluctuated over the years but is on average between around 5,000 and 7,000 kTPA, of which some 50% is made up of nitrogen-based fertilisers.

FIGURE 5. Evolution of fertiliser consumption in Indonesia since 2010



Source: Authors' own compilation, Fichtner (2024) based on (IFA, 2024)

PT Pupuk Indonesia (Persero) is the largest state-owned fertiliser producer in Indonesia, responsible for most of the country's fertiliser production and distribution and operating multiple fertiliser production facilities across Indonesia through its subsidiaries. The total installed capacity for ammonia production (basis for nitrogen-based fertilisers) is 7.1 MTPA.

Table 3 summarises the production facilities, including the location, capacity, and estimated hydrogen demand for the main fertiliser producers. It is assumed that ammonia is produced and further processed to urea, NPK or other nitrogen-based fertilisers, so that the estimated hydrogen demand relates directly to the ammonia production capacity.

Based on the current installed capacity for ammonia production (7,094 kTPA), the estimated hydrogen demand is 1.26 MTPA. This estimate represents a maximum demand since it assumes continuous full load operation of the plants. According to Persero, 5.96 MTPA of ammonia was produced in 2022 (Sawit Indonesia, 2023), for which roughly 1.1 MTPA of hydrogen would be required.

In 2023 Indonesia imported 5.4 MTPA of fertilisers for a total value of USD 2 billion (BPS, 2024a). A total of 0.35 MTPA of these imports was reported as nitrogen-based fertilisers (WITS, 2025d). On the other hand, Indonesia is a large exporter of ammonia in Southeast Asia, with total export volumes of 1.8 MTPA in 2023 (WITS, 2025e).

TABLE 3. Main fertiliser producers in Indonesia

Company	Location	Capacity [kTPA]	Estimated hydrogen demand [kTPA][1]
PT Pupuk Iskandar Muda (PIM)	Lhokseumawe, Aceh	NH_3: 759 Urea: 1,140 NPK: 500	134
PT Pupuk Sriwidjaja Palembang	Palembang, South Sumatra	NH_3: 1,831 Urea: 2,617 NPK: 300	324
PT Pupuk Kujang	Cikampek, West Java	NH_3: 660 Urea: 1,140 NPK: 230	117
PT Petrokimia Gresik	Gresik, East Java	NH_3: 1,105 Urea: 1,030 NPK: 2,620 Others: 2,870	196
PT Pupuk Kalimantan Timur	Bontang, East Kalimantan	NH_3: 2,739 Urea: 3,435 NPK: 230	485

Source: Authors' own compilation, Fichtner (2025) based on (Pupuk Indonesia, 2024)

1 Specific requirements of 0.177 tH2/tNH3 were assumed. The estimations are indicative, as they do not consider processes' efficiencies or part load operation.

2.1.3 The chemical industry

The Indonesian chemical industry is closely connected with the oil and gas industry, and principally comprises two sub-segments: basic oleochemical and biodiesel industry, and upstream petrochemical industry (Business Indonesia, 2025). Exports of chemical products totalled USD 24.9 billion in 2022, of which 30% was rubber and its products and 27% other chemicals. Imports totalled USD 36.2 billion, of which 31% was plastics and 28% other chemicals. The value of exports has steadily increased since 2020, but the country is still a net importer of chemical products.

Among the key players in the sector is Chandra Asri, Indonesia's largest integrated petrochemical company. It is the only domestic producer of ethylene, styrene monomer, and butadiene, and it is also the largest producer of polyethylene and polypropylene in Indonesia (PT Chandra Asri, 2019). Other relevant players include Lotto Chemical Titan and PT Asahimas Chemical, a joint venture between Asahi Glass Company Inc., Mitsubishi Corporation of Japan, and other investors. Table 4 summarises the petrochemical production facilities, including location and capacity.

Lotte Chemical plans to start construction of a new facility in Cilegon in 2025, projected to generate 1,000 kTPA of ethylene, 520 kTPA of propylene, and 250 kTPA of polypropylene.

TABLE 4. Main petrochemical companies in Indonesia

Company	Location	Capacity [kTPA]
PT Chandra Asri Petrochemical Tbk	Cilegon, Banten	Ethylene: 900* Propylene: 490* Others: 715
PT Lotte Chemical Titan Nusantara	Cilegon, Banten	Polyethylene: 450
PT Asahimas Chemical	Cilegon, Banten	Caustic soda (NaOH): 700 Vinyl chloride monomer (VCM): 900 Polyvinyl chloride (PVC): 750
PT Indorama Polypet Indonesia	Cilegon, Banten	Polyethylene: 102

* Precursors for further processing to other products

Source: Authors' own compilation, Fichtner (2024) based on (PT Chandra Asri, 2019), (Lotte Chemical Titan, 2022), (ASC, 2024), (Chandra Asri, 2023)

With regard to hydrogen peroxide (H_2O_2), Indonesia has several operational plants, as listed in Table 5, which shows their location and capacity. Nonetheless, the country remains a net importer of this product. It imported 41.5 kTPA in 2023 with a total trade value of USD 21.5 million (WITS, 2025a) and exported 20.9 kTPA with a total trade value of USD 13.6 million (WITS, 2025c).

Given total installed capacity of 126 kTPA (as 100% H_2O_2) and a specific hydrogen requirement of 59 kg H_2/tonne H_2O_2, hydrogen demand is estimated to be 7.4 kTPA (assuming full load operation without efficiency losses).

No dedicated cyclohexane facilities have been identified in Indonesia at the present time. In 2023, the country imported 1.4 kTPA of cyclohexane for a total trade value of USD 2.2 million (WITS, 2025b).

The variety of processes and products in the chemical industry together with a wide range of operational conditions make it challenging to determine specific hydrogen requirements for several segments. Published estimations of hydrogen demand for chemicals in Indonesia indicate a relatively constant requirement of approximately 32 kTPA since 2015 (ERIA, 2024).

Regarding methanol, Indonesia relies on imports to cover its local demand. While methanol consumption reached nearly 1.4 MTPA in 2023 (Chemanalyst, 2024), the country has only one methanol production plant, located in Bontang, with a production capacity of 660 kTPA (see Table 6), resulting in methanol imports of 1 MTPA (WITS, 2024).

Some projects have been announced that will increase methanol production capacity when operational. These include two methanol plants located in East Kalimantan and Nangroe Aceh Darussalam planned by PT Pupuk Indonesia for 2030 (Business Indonesia Post, 2024).

TABLE 5. Main hydrogen peroxide producers in Indonesia

Company	Location	Capacity [kTPA]
PT Peroksida Indonesia Pratama	Cikampek, West Java	25 (as 50% H_2O_2)
PT Hidrogen Peroxida Indonesia*	Merak, Banten	20 (100% H_2O_2)
PT Riau Andalan Pulp & Paper (RAPP)	Pangkalan Kerinci, Riau	66 (180 TPD)
PT Evonik Indonesia	Cikarang, West Java	unknown
PT Samator Intiperoksida	Gresik, East Java	25 (100% H_2O_2)

Source: Authors' own compilation, Fichtner (2025) based on (PIP, 2025), (Nuberg EPC, 2024), (IDN financials, 2024), (KD, 2024), (Evonik, 2025) and (Samator, 2025).

* Planned

TABLE 6. Main methanol producer in Indonesia

Company	Location	Capacity [kTPA]	Estimated hydrogen demand [kTPA][2]
PT Kaltim Methanol Industri (KMI)	Bontang, East Kalimantan	660	125

Source: Authors' own compilation, Fichtner (2025) based on (PT Kaltim Methanol, 2024)

2 Hydrogen demand was estimated on the basis of specific requirements of 0.189 t_{H2}/t_{NH3}.

2.1.4 The steel and metallurgy industry

Indonesia is a significant player in Southeast Asia's steel industry and was the world's tenth-largest exporter of steel in 2023 (ITA, 2025). In 2023, Indonesia produced 16.8 MTPA of crude steel (World Steel Association, 2024). Imports of iron and steel in Indonesia have been around 13 or 14 MTPA since 2021 (BPS, 2024b).

Among the key steel producers are Dexin Steel Indonesia, Krakatau Steel, and Gunung Steel Group. Table 7 summarises the main steel and metallurgy companies, including location, and capacity.

Currently there is no operational DRI furnace in Indonesia (CREA, 2024), and therefore there is no hydrogen requirement as a reducing agent for this process. Nonetheless, this remains a technological option since DRI production worldwide continues to increase and offers potential for future hydrogen demand. To give an initial idea of the potential in this sector, if the 16.8 MTPA of crude steel produced in 2023 were produced via DRI, this would generate a hydrogen demand of around 1 MTPA.

Several of the key companies listed in Table 7 have steel rolling mills operating, for which hydrogen might be required, including PT Krakatau Steel, PT Gunung Raja Paksi, PT AM/NS Indonesia, and PT Garuda Yamato Steel. Additionally, PT New Asia International, a partnership between China and Indonesia, planned two hot rolling mills with a total capacity of 5.5 MTPA that were expected to start operations in 2024, one in East Java (1.5 MTPA) and one in Morowali industrial zone, Sulawesi (4 MTPA) (SteelRadar, 2023).

TABLE 7. Main steel and metallurgy companies in Indonesia

Company	Location	Capacity [kTPA]
PT Dexin Steel Indonesia	Morowali, Central Sulawesi	7,000
PT Krakatau Steel	Cilegon, Banten	3,900
PT Gunung Raja Paksi (GRP) under a subsidiary of Gunung Steel Group	Cikarang, West Java	2,200
PT AM/NS Indonesia	Cikarang, Bekasi, West Java	Rolled steel: 400
PT Garuda Yamato Steel	Cikarang, Bekasi, West Java	Steelmaking: 1,000 Rolled steel: 900
PT Ispat Indo	Sidoarjo, East Java	700

Source: Authors' own compilation, Fichtner (2025), based on (Hanwa, 2023), (Hanwa, 2024), (AM-NS Indonesia, 2024), (GRP, 2021), (Krakatau Steel, 2024), (Reuters, 2022) and (Ispat Indo, 2024)

2.1.5 The oil industry

The oil industry in Indonesia is dominated by state-owned companies. Pertamina owns six oil refineries with a combined capacity of 1 million bbl/d, as shown in Table 8, which also includes locations and individual capacities.

The hydrogen demand for oil refining is highly dependent on the complexity of the refineries and the quality of the crude oil. Estimations of this demand show that it has remained at a fairly constant level of around 279 kTPA since 2015 (ERIA, 2024). Estimated hydrogen demand for each refinery was calculated with a constant specific requirement of 5.4 kg of hydrogen per tonne of oil, resulting from the total known demand (279 kTPA) and the total installed capacity (1.1 bbl/d).

TABLE 8. Main oil refineries in Indonesia

Refinery	Location	Capacity [kTPA]	Estimated hydrogen demand [kTPA]
RU II Dumai	Dumai, Riau	170,000	46
RU III Plaju	Palembang, South Sumatra	118,000	32
RU IV Cilacap	Cilacap, Central Java	348,000	94
RU V Balikpapan	Balikpapan, East Kalimantan	260,000	70
RU VI Balongan	Balongan, West Java	125,000	34
RU VII Kasim	Sorong, West Papua	10,000	3
Total	**-**	**1,031,000**	**279**

Source: Authors' own compilation, Fichtner (2025) based on (Pertamina, 2024) and (ERIA, 2024)

2.1.6 The food industry

The food industry in Indonesia is highly diversified. Indonesia has positioned itself as the largest producer of palm oil globally, and even though not all processed palm oil is used directly by the food industry, the processing of palm oil into cooking oil and margarine, for example, dominates the sector.

One main player in the Indonesian food industry is Indofood Sukses Makmur Tbk, one of the largest food companies in Indonesia. Under Indofood Agri Resources, 27 palm oil mills located in Sumatra and Kalimantan, as well as five crude palm oil (CPO) refineries primarily situated in major cities, including Jakarta, Medan, Surabaya, and Bitung, are currently operating. PT Wilmar, a subsidiary of Wilmar International, has 16 refineries of edible oils located in Indonesia. Table 9 summarises some of the main companies active in the palm oil industry, including their location and capacity.

The production of crude palm oil does not directly require hydrogen, since CPO is obtained by extraction (mechanical pressing). Nonetheless, further refining of CPO to obtain products such as margarine or hydrogenated vegetable oil for the food sector or oleochemicals does require hydrogen. Due to the variety of processes and products that can be obtained from processing palm oil, it is difficult to estimate the hydrogen requirement for the sector. To give a first indication of the order of magnitude of hydrogen demand for food processing, it is assumed that 30% of the total palm oil refining capacity (approx. 23 MTPA) is further processed to unsaturated fat (edible oil or margarine) with a specific hydrogen demand of 5 kg H_2/tonne of product, which would result in a total hydrogen demand of 34 kTPA. This value is only an indication of the order of magnitude expected for the sector; taking into consideration the size of the palm oil processing sector, this can be assumed to be the main driver for demand in the sector.

TABLE 9. Main companies in the palm oil industry in Indonesia

Refinery	Location	Capacity [kTPA]
Indofood Agri Resources, through its subsidiary PT Salim Ivomas Pratama Tbk (SIMP)	CPO refineries: North Sulawesi (Bitung), East Java (Surabaya), Jakarta, North Sumatra (Medan)	CPO refineries: 1,700
PT Wilmar Nabati Indonesia (subsidiary of Wilmar International)	North Sumatra (Kuala Tanjung), Riau (Dumai and Pelintung), West Sumatra (Padang), South Sumatra (Kumai), Banten (Serang), Jakarta (East Jakarta, Pulo Gadung), East Java (Surabaya, Gresik), Kumai (Central Kalimantan), West Kalimantan (Pontianak), Kalimantan Timur (Balikpapan), Jawa Barat (Kalbar), North Sulawesi (Bitung)	CPO refineries: approx. 10,000
Golden Agri-Resources (GAR)	South Sumatra (Palembang), Kalimantan (Tarjun), Java (Surabaya)	CPO refineries: 4,980
Musim Mas	North Sumatra, Padang (West Sumatra), Dumai (Riau), Batam (Riau Islands), Bagendang (Central Kalimantan), Bitung (North Sulawesi), Surabaya (East Java), West Java, Palembang (South Sumatra)	CPO refineries: approx. 4,000
Apical Group	Jakarta (Marunda), West Sumatra (Padang), Kalimantan (Balikpatan), Sumatra Riau (Dumai)	1,200
PT Pacific Indopalm Industries	Sumatra Riau (Dumai)	1,200
Taminas	Medan, Dumai	unknown

Source: Authors' own compilation, Fichtner (2025) based on (AgriFood, 2024), (Wilmar, 2025), (GAR, 2023), (Musim Mas, 2025), (Apical, 2025), (Indopalm, 2024)

2.1.7 The glass industry

Indonesia's glass industry is concentrated mainly in the production of bottles, but there are key players in the production of e.g. flat glass too. Hydrogen in the glass industry is mainly used as a reducing agent and for controlled atmospheres in float glass production, or for specialty glass production. Table 10 summarises the main glass industry companies in Indonesia, including their location and capacity.

Given that float glass is the most widely used method for producing flat glass globally, the production capacities for both flat glass and float glass serve as the foundation for estimating potential hydrogen demand. With a total capacity of 1,778 kTPA and an assumed specific hydrogen demand of 0.4 kg per tonne of glass, the estimated hydrogen demand is calculated to be 0.71 kTPA.

TABLE 10. Main glass industry companies in Indonesia

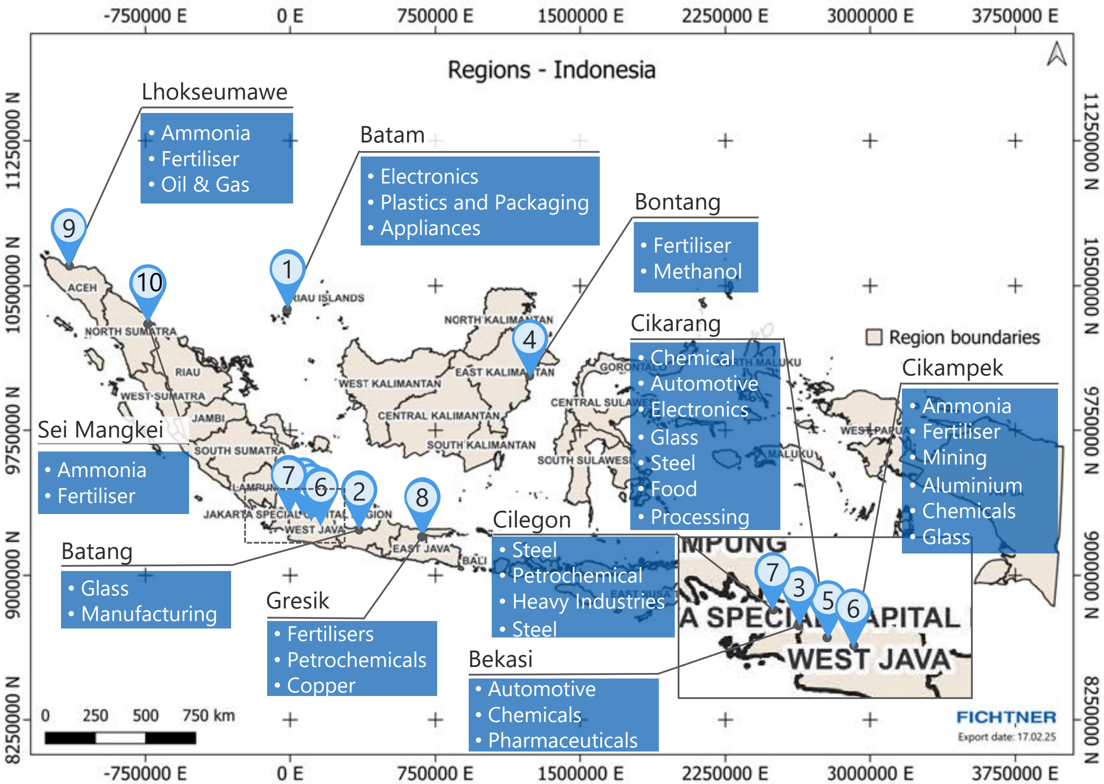
Refinery	Location	Capacity [kTPA]
PT Asahimas Flat Glass Tbk	Cikampek and Sidoarjo, East Java	Flat glass: 720 Mirror: 6.8 Mm^2/a Automotive glass: 5.8 Mm^2/a
PT Mulia Industrindo Tbk	Cikarang, Bekasi	Float glass: 620 Glass container: 221 Glass blocks: 97 Automotive safety glass: 195,000 car sets per annum
KCC Glass Indonesia	Batang, Central Java	Flat glass: 438

Source: Authors' own compilation, Fichtner (2024) based on (PT Asahimas Flat Glass, 2024), (PT Mulia Industrindo, 2024) and (Glass International, 2024)

2.2 Industrial clusters and enabling infrastructure

The industrial sector in Indonesia is not evenly distributed across all islands. Certain regions are significantly more relevant and concentrated in terms of industrial activity, largely due to their resources, infrastructure, and accessibility. A selection of main industrial clusters in Indonesia is depicted in Figure 6. From the total of 14 listed industrial clusters, 10 have been prioritised based on their higher likelihood of hydrogen use, with potential for transitioning from grey to green hydrogen. Further details of the industrial clusters are listed in [Annex 1 Details of industrial clusters](#).

FIGURE 6. Main industrial clusters in Indonesia



Key Companies

No.	Company	[kTPA]
1	**Musim Mas** (Vegetable Oil)	-
2	**KCC Glass Indonesia** (Glass)	438
3	**PT AM/NS** (Steel)	-
4	**PT Pupuk Kalimantan Timur** (Fertiliser)	6,404
	PT KMI (Methanol)	660
5	**PT GRP** (Steel)	2,200
	PT Garuda Yamato (Steel)	1,900
	PT Mulia Industrindo (Glass)	-
6	**PT Pupuk Kujang** (Fertiliser)	2,030
	PT Peroksida (Hydrogen Peroxide)	25
	PT Asahimas Flat Glass Tbk (Glass)	-
7	**PT Chandra Asri** (Petrochemical)	2,105
	PT Asahimas Chemical (Petrochemical)	2,350
	PT Krakatau Steel (Steel)	3,900
8	**PT Petrokimia Gresik** (Fertiliser)	7,625
	PT Samator Intiperosida (Hydrogen Peroxide)	25
	PT Wilmar Nabati (Vegetable Oil)	-
9	**PT PIM** (Fertiliser)	2,399
10	**Unilever Oleochemical Indonesia** (Petrochemical)	-
	PT Sime Darby Oils (Petrochemical)	

Source: Authors' own compilation, Fichtner (2025)

One or more processes requiring hydrogen have been identified in these clusters, including petroleum refining, chemicals production, palm oil refining, methanol production, and glass production.

The industrial clusters are concentrated in Java (Central, West, East and Banten), Sumatra (North, South, Riau and Aceh), Kalimantan (Bontang), and Riau Islands (Batam). Well-developed infrastructure is in place for these industrial clusters, and accessibility is provided:

- **Grid connection:** Connection to the grid is available in all selected industrial clusters and supports energy-intensive industries such as steel and petrochemicals. The implementation of large-scale GH_2 projects will require expansion of the transmission and distribution lines only if they are connected to the grid. The implementation of large-scale projects may involve connecting to the grid for backup services. However, theoretically, excess electricity generated from green hydrogen projects could also be injected into the grid, provided that regulations are introduced in the future to allow for this. Such a setup would enable more efficient utilisation of the generated electricity.
- **Water supply:** All clusters have an adequate water supply from local sources. Nonetheless, the implementation of large-scale GH_2 projects will require sustainable water sources, which can be obtained by seawater desalination, most likely near to the production sites. Some projects have been announced, including Freeport Indonesia's Manyar Smelter Project to supply 1,400 m^3 per hour of desalinated seawater to the Manyar copper smelter and refinery in East Java (Indonesia Miner, 2022).
- **Transport infrastructure:** Road conditions influence transport capacities and related costs, being a key driver of competitiveness for the clusters. In general, the clusters have a good road infrastructure. In some areas the roads are improving as part of the development of Special Economic Zones, as is the case in Sei Mangkei and Arun-Lhokseumawe.
- **Ports:** The archipelagic nature of the country allows for easy access to large ports for all clusters. The ports are adequate for the export of various goods.

2.3 Pilot projects

Indonesia is advancing in green electricity and hydrogen initiatives, with multinational corporations such as PT Pertamina, Mitsubishi, Fortescue Metals Industries, Samsung, and Hyundai already exploring GH_2 investments and several projects and infrastructure developments underway (GH_2, 2024). Specific pilot projects listed in the national hydrogen strategy are as follows (Ministry of Energy and Mineral Resources, 2023):

OPERATIONAL HYDROGEN PILOT PROJECTS:

- **Nubika Jaya biogas extraction for bio-hydrogen production:** The project, located in North Sumatra, has been operational since 2010. It utilises an anaerobic digestion (AD) system to process wastewater, producing biogas that is subsequently used for hydrogen production via a Hydro-Chem process licensed by Linde AG. The biogas is processed by first removing sulphur (H_2S), followed by converting methane into hydrogen using steam reforming reactions. (JQA, 2009)
- **PLN's Hydrogen Fuel Cell Buses:** PLN (Perusahaan Listrik Negara) is testing hydrogen fuel cells in public transportation, particularly for buses, to evaluate performance and feasibility.

PLANNED HYDROGEN PILOT PROJECTS:

- **Pertamina's GH_2 pilot project:** Pertamina is exploring different pilot production facilities in various regions. The first project is already underway since the beginning of 2024 at a geothermal site in Tanggamus Regency, Lampung Province with a target production capacity of 100 kg per day. Further hydrogen projects are planned over the next few years. (Petromindo, 2024)
- **Hydrogen production for electricity generation:** PLN and PT HDF Energy Indonesia aim to replace a diesel power plant with a hydrogen-based power plant on Sebira Island (Seribu Islands, Jakarta) (Petromindo, 2023).
- **Sumba Island Renewable Energy Initiative:** Part of a broader initiative to transform Sumba into a renewable energy hub. The primary objective of the project is to establish a robust and sustainable hydrogen production and storage facility on Sumba Island. The project aims to leverage Sumba Island's abundant renewable energy resources, including solar and wind power, to produce green hydrogen (Energy News, 2024).

Further to the small pilot projects mentioned on the previous page, some large-scale projects have also been announced:

- A cooperation agreement between the state-run fertiliser manufacturer PT Pupuk Indonesia, state-owned oil and gas company PT Pertamina, and Mitsubishi has been signed to develop the green hydrogen and green ammonia value chain. PT Pertamina is investing USD 11 billion for green hydrogen as part of its green energy target.
- ACWA Power develops projects together with PT Perusahaan Listrik Negara (PLN) and PT Pupuk Indonesia. One of them, the Garuda Hidrogen Hijau Project, aims to produce 150 kTPA of green ammonia, starting commercial operations in 2026 (Acwa Power, 2023).
- Fortescue Future Industries (FFI) and the North Kalimantan Provincial Government of the Republic of Indonesia have signed a cooperation agreement to explore green hydrogen projects for domestic and export usage in Indonesia in July 2021.
- Global Green Growth Institute (GGGI) is collaborating with Samsung and Hyundai on a USD 1.2 billion clean energy project in Indonesia to produce green hydrogen. Samsung is doing the design and the validity study, while Hyundai is responsible for the green ammonia shipping. The green hydrogen will be harvested from a geothermal energy source in the Sarulla Block, North Sumatra, and will be supplied to the nearby Sei Mangkei Industrial Zone's steel and cement making factories.
- Sembcorp and PT PLN's green hydrogen project: 100,000 TPA of GH_2 to be exported to Singapore. The project aims to create a regional green hydrogen hub connecting Sumatra, the Riau Islands, and Singapore (Offshore Energy, 2024).

3

Green hydrogen potential in Indonesia and use cases

Indonesia has the potential to become a major player in the global hydrogen economy, leveraging its abundant renewable energy resources, industrial demand, and strategic export capabilities. With existing hydrogen consumption in oil refining, ammonia-based fertilisers, and the chemical sector, as well as coastal access to key international markets in Asia and beyond, the country is well-positioned to develop a thriving green hydrogen industry. However, challenges such as grid reliability, seasonal variations in renewable energy production, regulatory uncertainties, and financing constraints must be addressed to unlock this potential.

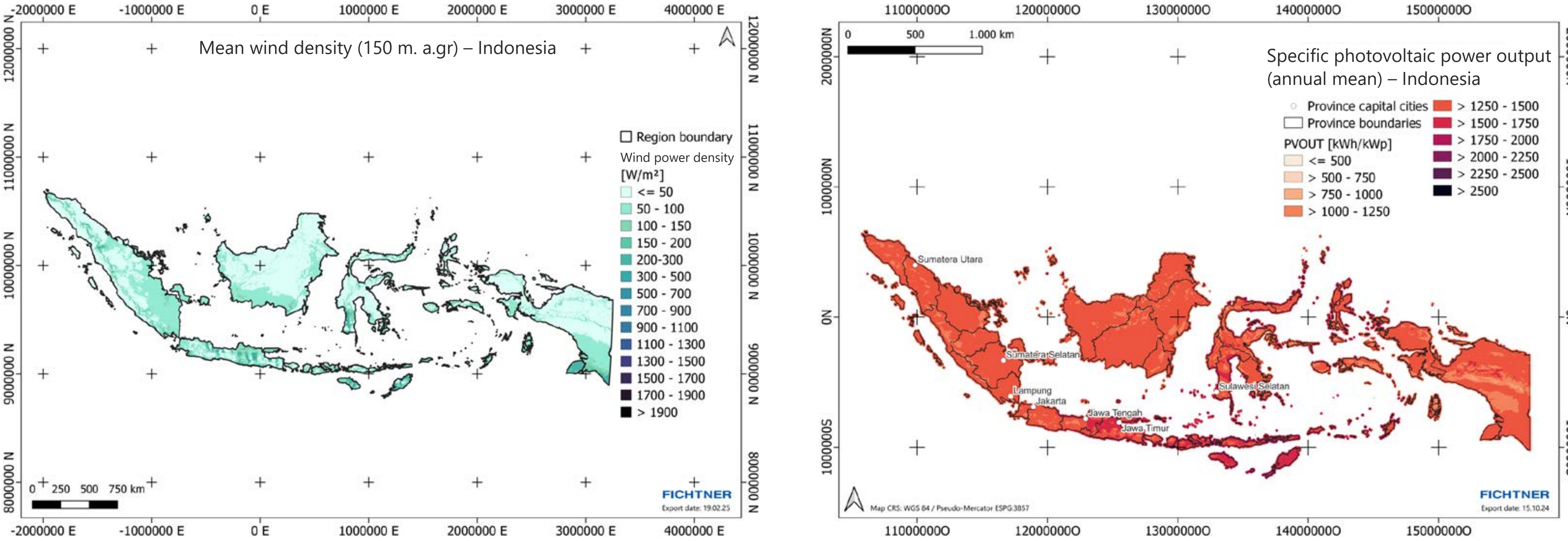
3.1 Renewable resource potential within Indonesia

Indonesia possesses a diverse mix of renewable energy resources that can be utilised for green hydrogen production. The most promising sources include hydropower, geothermal energy, solar power, and wind energy, though their potential varies across the country:

- **Geothermal energy:** Indonesia is one of the world's leading geothermal energy producers, with substantial reserves in Java, Sumatra, and Sulawesi. This stable, baseload renewable energy source presents an opportunity for steady hydrogen production without the intermittency challenges of solar or wind power.
- **Hydropower:** Indonesia has significant hydropower potential, particularly in Sumatra, Kalimantan, and Sulawesi, where large rivers provide consistent flow. While hydropower already contributes to the national grid, its seasonal variations may pose challenges for year-round hydrogen production. However, in combination with storage systems it could provide a stable and low-carbon electricity source for localised electrolysis projects.
- **Solar energy:** Indonesia receives high solar irradiation, particularly in eastern regions such as Nusa Tenggara and southern Sumatra, where PV projects can achieve high capacity factors.
- **Wind energy:** Wind potential in Indonesia is moderate, with the best locations in West Java, South Sulawesi, and East Nusa Tenggara. While not as competitive as solar or geothermal energy, wind power can complement other renewable sources to ensure a stable electricity supply for electrolysis-based hydrogen production.

Water availability is another key factor for green hydrogen production. Indonesia benefits from abundant freshwater resources, but local water shortages and competing demands from agriculture, industry, and domestic consumption could create regional challenges. In coastal areas, seawater desalination may be required to ensure a stable water supply for electrolysis without straining existing freshwater resources. However, desalination costs are expected to be a small fraction of the total levelised cost of hydrogen (LCOH), making it a viable solution for large-scale hydrogen projects.

FIGURE 7. Mean wind power density and specific photovoltaic power output



Source: Authors' own compilation, Fichtner (2025) based on (Neil N. Davis, 2024)[3]

Source: Authors' own compilation, Fichtner (2025) based on (Global Solar Atlas, 2024)[4]

3 Data obtained from the Global Wind Atlas version 3.3, a free, web-based application developed, owned, and operated by the Technical University of Denmark (DTU). The Global Wind Atlas version 3.3 is released in partnership with the World Bank Group, utilising data provided by Vortex, using funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: https://globalwindatlas.info

4 Data obtained from the Global Solar Atlas 2.0, a free, web-based application developed and operated by the company Solargis s.r.o. on behalf of the World Bank Group, utilising Solargis data, with funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: https://globalsolaratlas.info

3.2 Potential use cases

Indonesia's hydrogen industry is primarily driven by ammonia-based fertiliser production, oil refining, methanol synthesis, and chemical manufacturing. The sector is dominated by state-owned enterprises, with on-site hydrogen production mainly derived from fossil fuels. While green hydrogen adoption is still in its early stages, large-scale projects and industrial decarbonisation initiatives offer significant opportunities for expanding green hydrogen applications.

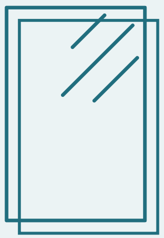
These potential use cases can be broadly categorised into small-scale and large-scale applications, reflecting global trends in the early development of hydrogen markets.

SMALL-SCALE USE CASES (ELECTROLYSER CAPACITY: 1+ MW)

Small-scale green hydrogen projects serve industries with moderate hydrogen demand or decentralized production needs. These setups prioritise on-site or near-site generation to minimise logistics costs and seamlessly integrate with existing processes.

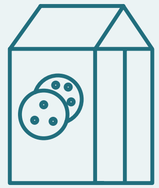
Electrolysers will then be typically powered by local wind or solar PV plants, supported by battery energy storage or hydrogen storage to manage fluctuations in electricity supply and hydrogen demand. In most cases, the hydrogen is consumed directly on site, ensuring efficiency and reliability.

Typical small-scale applications include electronics, specialty glass production, welding processes, and the food industry – either for hydrogenation or as protective gas in food packaging. In Indonesia, potential applications include:



1. FOOD INDUSTRY

- Indonesia is the largest producer of palm oil globally, with a major refining industry.
- Even if hydrogen is not required for the production of refined palm oil, it is essential for subsequent processes such as its hydrogenation for improving shelf life, texture, and stability of the products.
- Transitioning from fossil-based hydrogen to green hydrogen could reduce the carbon footprint of Indonesia's edible oil industry, aligning with global sustainability standards.
- The palm oil refining industry is highly concentrated in Sumatra, Kalimantan, and Java, where large-scale processing facilities and export terminals are located.



2. GLASS MANUFACTURING

- Indonesia has a strong glass manufacturing industry, including flat glass, container glass, and automotive glass production.
- Hydrogen can be used as a reducing agent and for controlled atmospheres in float glass and specialty glass manufacturing.
- The glass manufacturing sector is concentrated in West Java, East Java, and Central Java, where major production facilities are located.

LARGE-SCALE USE CASES (ELECTROLYSER CAPACITY: 10 MW AND ABOVE)

Large-scale green hydrogen projects serve industries with high and continuous hydrogen demand, maximising economies of scale through larger electrolyser installations and the utilisation of optimal wind and solar resources.

These projects typically feature large renewable energy facilities paired with nearby large-scale electrolysers, supported by infrastructure for electricity transmission, water supply, wastewater management, and hydrogen storage and transport to off-takers or ports. Extensive hydrogen storage is essential either to balance production fluctuations without disrupting downstream processes or to accommodate the periodic nature of maritime transport for export-oriented projects.

Unlike smaller-scale projects, large electrolysers are housed in dedicated buildings, as containerised solutions are more common for smaller installations. In some cases, desalination units may be required to ensure a sustainable water supply, depending on local availability.

Typical large-scale applications include ammonia and fertiliser production, chemicals (including methanol), and crude oil refining. In the future, iron & steel and cement may also emerge as major hydrogen consumers.

In Indonesia, the primary opportunities include:

1. AMMONIA AND FERTILISER PRODUCTION

- Indonesia is one of the world's largest ammonia producers, with a total installed ammonia production capacity of 7.1 MTPA, primarily operated by PT Pupuk Indonesia and its subsidiaries.
- Currently, ammonia production is dependent on natural gas, making it one of the largest contributors to industrial hydrogen demand in the country.
- Indonesia exported 1.8 MTPA of ammonia in 2023, positioning it as a key player in the Southeast Asian ammonia market.
- Transitioning to green ammonia production could significantly reduce Indonesia's carbon footprint and enhance its global competitiveness in the growing market for low-carbon fertilisers and green products.

2. OIL REFINING AND PETROCHEMICALS

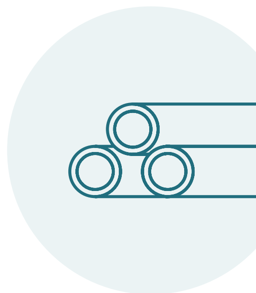
- Indonesia's refining industry, led by Pertamina's six major refineries, requires hydrogen for key processes such as hydrotreating and hydrocracking, which are essential for removing sulphur and improving fuel quality.
- Retrofitting existing refineries to use green hydrogen instead of natural gas-based hydrogen could substantially reduce emissions and aligns with Indonesia's energy transition goals.

3. METHANOL PRODUCTION

- Indonesia has one methanol production facility, in East Kalimantan, that is estimated to consume approximately 125 kTPA of hydrogen.
- Indonesia imported 1 MTPA of methanol in 2023 to meet local demand, highlighting the need for expanded domestic production.
- New planned methanol plants in East Kalimantan and Nangroe Aceh Darussalam will increase hydrogen demand in the future.

4. STEEL AND METALLURGY INDUSTRY

- Indonesia is one of Southeast Asia's largest steel producers.
- Key steel manufacturers such as Dexin Steel Indonesia, Krakatau Steel, and Gunung Steel Group operate in Central Sulawesi, Banten, and West Java.
- Currently, Indonesia does not have any operational direct reduced iron (DRI) furnaces, but H_2-DRI presents a long-term decarbonisation opportunity.
- Global markets increasingly demand low-emission steel, creating new export opportunities for Indonesia's steel sector.



TECHNO-ECONOMIC CALCULATIONS OF THE USE CASES

To provide a preliminary indication of techno-economic feasibility for projects of varying scales, four different scenarios were assessed for direct hydrogen use at the Bekasi cluster, where chemicals and pharmaceuticals are currently produced. Here, a transition to green hydrogen could be considered in the short to medium term. For these selected cases, the analysis examined the levelised cost of hydrogen based on different renewable energy mixes of PV and wind and a power purchase agreement (PPA) based on geothermal energy, necessary to meet a given annual hydrogen demand. Different electrolyser sizes were used. The main results of these three cases are summarised in the Table 11. These results are based on model renewable profiles at the location (3°08'1"N, 99°21'00"E). It should be noted that the results may vary significantly if industries in other parts of the country are chosen, for example with different wind resources nearby, or if utility-scale projects with significantly larger component sizing are planned.

The values are given as average values over the project lifetime and include inflation, as well as an assumed price increase of grey hydrogen of 2% above inflation. The LCOH of grey hydrogen, for example, is therefore based on a current price of USD 4.3 per kg (assumes purchase from external supply, including transport), which increases substantially during the modelling period.

TABLE 11. Estimated local hydrogen demand for main sectors

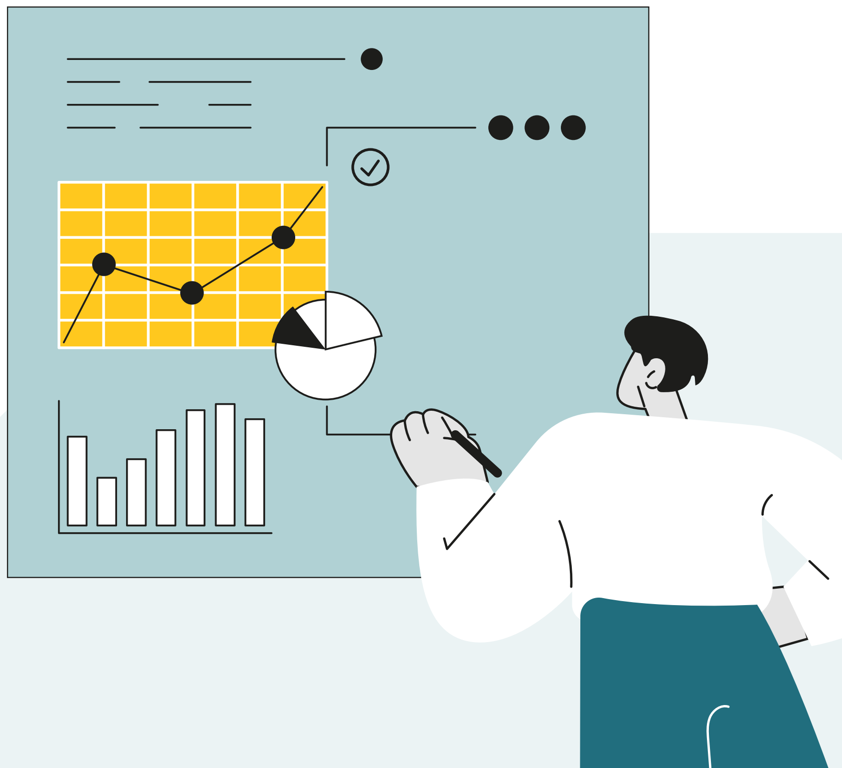
Case	Small-scale H_2 (wind & PV)	Small-scale H_2 (PV only)	Large-scale H_2 (wind & PV)	Large-scale H_2 (geothermal)
Demand (H_2) in tonnes/a[5]	45	45	450	450
Installed RE (capacity) in MW	PV: 3.3 Wind: 0.5	PV: 3.2	PV: 29.2 Wind: 2.0	PPA from geothermal plant
Electrolyser size in MW	0.8	0.9	9.1	3.1
Weighted average cost of capital (WACC) (%)	7.6	7.6	7.6	7.6
Total investment in million USD	5.5	4.6	43.3	8.5
Oxygen sales in million kg	0.34	0.34	3.4	3.4
Excess RE sales/consumed in GWh[6]	1.7	1.4	11.5	0[7]
LCOH grey (USD/kg)	7.0	7.0	7.0	7.0
LCOH proposed case/green (USD/kg)	12.3	10.1	8.6	8.9
Net present value (NPV) in million USD	-1.0	-0.4	-4.6	-7.2
Finance gap (USD/kg)	5.4	3.2	1.5	1.9

Source: Analyses performed by GIZ (2025)

5 Within the optimization process, least cost project setups are designed that match the demand by +-3%
6 Excess RE are calculated for the value chain including ammonia. If only H_2 is to be produced, the amount of excess renewables can be increased by ~5%.
7 No excess renewables as PPA is concluded (no own production of renewable power)

The complete assumptions, sizing, cost breakdown, financial parameters, and results are detailed in Annex 2 Techno-economic calculations. Based on the results presented in the Table 11, the following can be concluded:

- **Resource utilisation and cost analysis:** The analysis reveals that wind resources at the selected locations are insufficient for effective electricity generation, as indicated by the lower LCOH for green hydrogen in the 'small-scale H_2 (PV only)' case compared to the 'small-scale H_2 (wind & PV)' case, even though only a small wind power addition was enforced.
- **Financial viability:** With an average LCOH for grey hydrogen of USD 7.0 per kg, the 'large-scale H_2 (wind & PV)' and 'large-scale H_2 (geothermal)' cases show the lowest financing gap at about USD 1.5 per kg. However, the geothermal case shows a very different financial case, due to the much lower initial investment but higher energy costs. Therefore, the assessment of this case in comparison to others strongly depends on the assumed interest and depreciation rates, as well as preferences of the implementing company. This can also be seen in the different relative assessment in the LCOH (which considers pre-interest and pre-tax cashflows) vs. NPV or IRR, which include tax and interest rates. In general, the results underline the economies of scale for the large-scale plants and the insufficient wind conditions, benefitting the PV-only plant. A large-scale PV-only plant is expected to have even lower levelised costs, although the difference would be small given the small wind sizing. Lower LCOHs for grey hydrogen, for instance if a facility has piped access to grey hydrogen from a nearby production facility (or its own steam reformation plant), will correspondingly increase the finance gap. By leveraging a single funding source or a mix of the funding sources described further in section 4.3, the finance gap might be closed to make a project economically feasible.



Given that much of the current hydrogen use in Indonesia is directly linked to ammonia-based fertiliser production, a complementary techno-economic analysis was conducted for three ammonia use cases that align with the hydrogen use cases presented on the previous pages. The results are summarised in the following table. Levelised costs are provided as average nominal values considering the project lifetime of 25 years.

- **Financial viability:** Despite having financial gaps and negative net present values in all scenarios, the 'large-scale NH3 (wind & PV)' case has the smallest financial gap among the wind and PV cases at USD 1.2 per kg of ammonia, highlighting its potential for large-scale implementation. As with hydrogen, the remaining gap might be closed by leveraging funding mechanisms. The geothermal case shows an even lower LCOA, however, the lower NPV shows it to be less feasible economically compared to large-scale wind & PV.[8]
- **Investment returns:** Although the project IRR is modest across all cases, the 'large scale NH3 (wind & PV)' scenario offers the highest return at 2.2%.

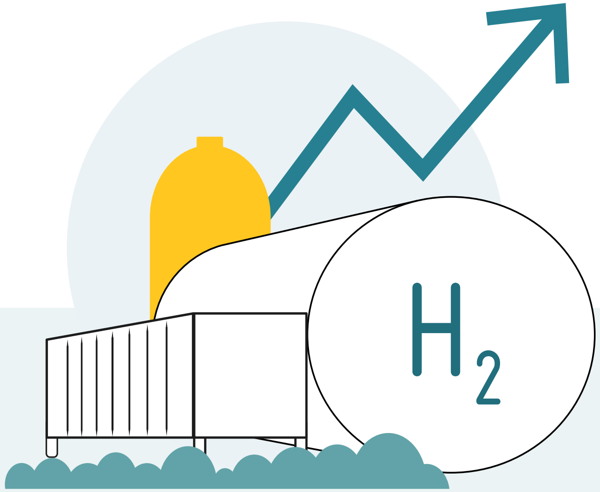
TABLE 12. Techno-economic calculations for ammonia use cases

Case	Small-scale NH_3 (wind & PV)	Small-scale NH_3 (PV only)	Large-scale NH_3 (wind & PV)	Large-scale NH_3 (geothermal)
Demand (NH_3) in tonnes/a	270	270	2,700	2,700
Installed RE (capacity) in MW	PV: 3.3 Wind: 0.5	PV: 3.2	PV: 29.2 Wind: 2.0	PPA from geothermal plant
Electrolyser size in MW	0.8	0.9	9.1	3.1
WACC (%)	7.6	7.6	7.6	7.6
Total investment in million USD	6.4	5.3	48.0	13.2
LCOA grey (USD/kg)	0.9	0.9	0.9	0.9
LCOA proposed case (USD/kg)	2.7	2.3	2.1	1.9
Oxygen sales in million kg	0.34	0.34	3.4	3.4
Excess RE sales/consumed in GWh	1.7	1.4	11.5	0
NPV in million USD	-2.2	-1.7	-14.2	-17.1
Finance gap (USD/kg)	1.8	1.4	1.2	1.0

Source: Analyses performed by GIZ (2025)

8 While the lower in initial investment causes a lower LCOA, the timing of the cashflows with all relevant factors, including taxation, depreciation, as well as debt repayments (which are not considered in LCOA calculation) result in a lower NPV.)

Overall, and under current assumptions, the results show the general rationale of larger projects being more cost efficient than small-scale projects. Nevertheless, they also require higher initial investment and the lower LCOH/LCOA is still not enough to reach a positive NPV. It is therefore clear that these projects are not economically feasible in the short term without intensive funding. From a funding perspective it might be more feasible to go for small-scale projects as the funding required to set up these projects is lower in terms of absolute value, but this is heavily dependent on the funding scheme that is to be used.



It is important to note that the aforementioned options provide an estimate of potential green hydrogen and ammonia costs; however, cost evaluations should be conducted on a project-by-project basis since factors such as the local renewable profile and the required industry's offtake profile (the analysis in this study is based on a constant profile) can significantly influence the levelised cost, particularly due to their impact on the sizing of the electrolyser and storage system required. This effect is smaller for ammonia than hydrogen as the former has significantly lower storage costs. Additionally, securing an off-taker for the produced oxygen can be challenging, as revenue from the sale of this by-product generally does not justify investment in extensive transport infrastructure. If an off-taker can be found, however, oxygen revenues can play a big role in financial viability: as significantly more oxygen is produced than hydrogen, oxygen can constitute a similar or even higher share of revenues despite the typically substantially lower price per kg. The calculation further assumes that the full amount of renewable electricity generated can be used by the industrial facility also using the hydrogen, or sold to a nearby industry for an average price of USD 65 /MWh. It is likely that the industries will be interested in purchasing the otherwise curtailed renewable electricity, but this might not always be the case and without the sale of excess renewables, battery storage might become an option. In certain scenarios, it may further be feasible to derive additional benefits from using the electrolyser's waste heat for applications such as district heating or industrial pre-heating processes.

3.3 Analysis of hydrogen production potential

Indonesia's large-scale green hydrogen production potential is driven by its renewable energy resources, extensive coastline, and well-established industrial hubs. With abundant hydropower in Sumatra and Kalimantan, significant geothermal capacity in Java, and high solar irradiation in East Nusa Tenggara and Sulawesi, Indonesia has the ability to generate low-cost, low-carbon electricity for electrolysis-based hydrogen production.

Indonesia's archipelagic nature requires a tailored approach to hydrogen production, with a mix of standalone projects in remote areas and interconnected energy grids in industrial hubs to balance renewable energy generation, industrial demand, and storage needs for stable, year-round hydrogen supply.

Small-scale hydrogen projects are best suited for Indonesia's industrial clusters, where on-site hydrogen production can reduce transportation costs and supply risks. The fertiliser and ammonia industries in East Kalimantan, Sumatra, and West Java already have significant hydrogen demand, making them ideal candidates for early adoption of green hydrogen. Additionally, the palm oil processing industry in Riau, North Sumatra, and Kalimantan could integrate green hydrogen for edible oil hydrogenation, reducing reliance on fossil-based hydrogen. The glass industry in Cikarang and Batang and the chemical industry in Banten also present promising small-scale hydrogen use cases.

Indonesia's export potential for hydrogen and its derivatives is strengthened by its strategic location in Southeast Asia. The country's major ports in Jakarta, Surabaya, and Balikpapan already support extensive energy exports. Leveraging this existing infrastructure for hydrogen exports could enable Indonesia to supply growing markets in Japan, South Korea, and Singapore, where demand for low-carbon hydrogen is rising. In the long term, Indonesia's existing natural gas pipelines could be retrofitted for hydrogen transport, facilitating regional trade and supporting domestic hydrogen distribution to key industrial zones.

3.4 Multi-criteria assessment for small-scale hydrogen projects

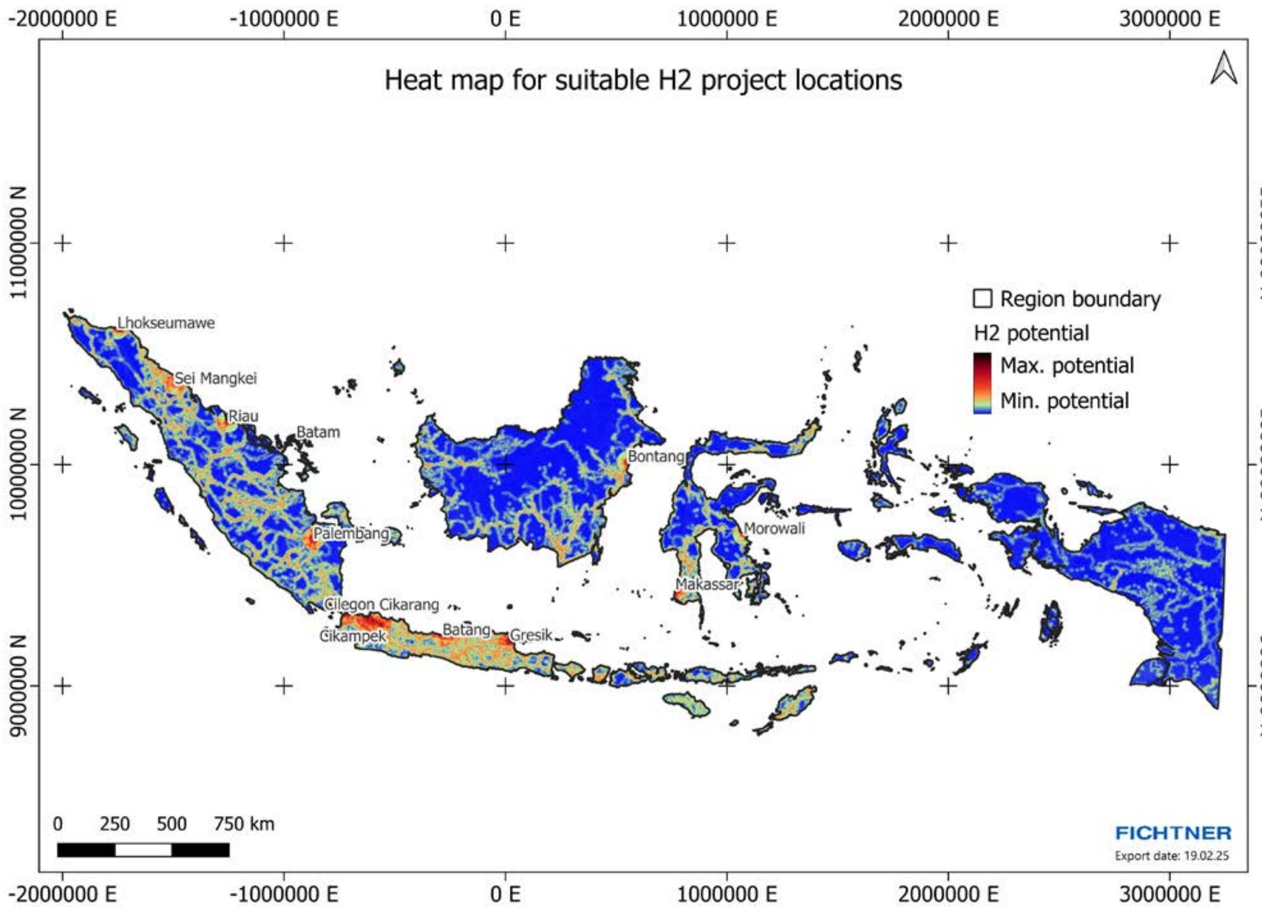
A multi-criteria assessment (MCA) was carried out in order to identify optimal locations for small-scale hydrogen projects. The evaluation considered:

- Renewable energy availability (wind and solar potential)
- Proximity to industrial clusters (potential off-takers)
- Access to water resources (for electrolysis)
- Connection to existing energy and transport infrastructure

Each criterion was assigned specific scoring thresholds based on factors such as distance to off-takers, high-voltage grid connections, water sources, roads, and port facilities. Industrial proximity received the highest weighting, followed by grid access, renewable resource quality, and water availability. Transportation infrastructure (roads and ports) was also factored in to assess export feasibility.

The results of the MCA are visually represented in Figure 8 highlighting high-potential areas in red as prime locations for engaging industrial off-takers and initiating project development. Areas with less favourable conditions are marked in blue, indicating greater development challenges. In particular, the island of Java demonstrates greater potential due to its higher density of industrial zones, along with more developed electrical and road infrastructure. Conversely, other islands exhibit lower potential as they lack or have fewer industrial zones and infrastructure, leading to extensive areas with limited potential.

FIGURE 8. Country heat map indicating potential locations for green hydrogen pilot projects



Source: Authors' own compilation, Fichtner (2025)

4

The way forward

4.1 Opportunities and supporting framework

The analysis of Indonesia's energy sector and its potential for green hydrogen adoption highlights both opportunities and challenges in establishing a sustainable hydrogen economy. With abundant renewable energy resources – particularly solar, wind, and geothermal – and the government's plan to support the development of clean hydrogen, Indonesia has a strong foundation for green hydrogen production. Additionally, its strategic location and industrial activities offer potential for both domestic utilisation and exports.

This section outlines Indonesia's key advantages, including its renewable energy potential and emerging hydrogen policies, while also examining challenges such as the need for supportive market frameworks to enable a competitive and sustainable hydrogen economy.

While the country's energy mix remains heavily reliant on fossil fuels, integrating green hydrogen could support industrial decarbonisation, enhance energy security, and position Indonesia as a key player in regional hydrogen markets. Additionally, growing international interest and funding for clean hydrogen projects further strengthen Indonesia's position as a potential player in Asia's premium off-take markets.

- **Renewable energy potential for green hydrogen production:** With significant solar and geothermal resources, Indonesia has the capacity to generate renewable electricity for large-scale green hydrogen production. While hydropower is more limited due to geographical constraints, targeted investments in solar PV and hybrid systems could provide stable power sources for electrolysis.
- **Strategic position for hydrogen exports:** Indonesia's extensive coastline and well-developed industrial ports, such as those in Java and Sumatra, make it a strong candidate for hydrogen exports. Its proximity to key Asian markets, including Japan, South Korea, and Singapore, enhances its potential as a supplier of green hydrogen and its derivatives.
- **Opportunities for industrial integration:** Indonesia's fertiliser, ammonia, refinery, and petrochemical industries present immediate opportunities for green hydrogen adoption. These sectors already rely on hydrogen as a feedstock, making them prime candidates for transitioning to green hydrogen. Over time, hydrogen could also support other industrial sectors (e.g. steel and glass).
- **International partnerships and investment:** Indonesia is attracting interest from global energy players, with collaborations involving companies such as Mitsubishi and TEPCO, as well as projects like Garuda Hidrogen Hijau. These partnerships can facilitate technology transfer, infrastructure development, and market expansion.
- **Job creation and social infrastructure development:** The transition to green hydrogen offers opportunities for local economic growth, with investments in renewable energy, water supply, and transport infrastructure benefiting both industry and surrounding communities. Additionally, Indonesia's well-established industrial base provides a strong foundation for developing the skilled workforce needed for the hydrogen economy. Existing expertise in sectors such as oil refining, petrochemicals, and manufacturing can facilitate workforce upskilling, ensuring a smoother transition to clean energy technologies while creating new employment opportunities.

For Indonesia to fully unlock its green hydrogen potential, a well-defined framework encompassing policy, regulatory, and technological measures is essential. This framework should provide clarity for investors, ensure the integration of hydrogen into the national energy strategy, and enable the development of necessary infrastructure.

- **Policy framework:** Indonesia has taken significant steps toward integrating hydrogen into its long-term energy strategy. Hydrogen was first mentioned as an energy source in Regulation No. 79 (2014), which together with Presidential Regulation No. 22 (2017) set the foundation for future policy developments. The National Hydrogen Strategy (2023) further defines specific production targets, infrastructure development measures, and international cooperation initiatives. The government aims to attract up to USD 25.2 billion in private investment between 2031 and 2060 to accelerate clean hydrogen development, with an emphasis on leveraging Indonesia's renewable energy potential. Additionally, international partnerships, such as the USD 20 billion Just Energy Transition Partnership (JETP) and financing from institutions like the World Bank and Asian Development Bank, play a key role in supporting Indonesia's transition to clean hydrogen. A clear roadmap aligning hydrogen development with Indonesia's National Energy Policy (RUEN) and Net Zero Emission (NZE) targets will be essential to ensuring long-term growth.
- **Regulatory framework:** Indonesia's regulatory framework for green hydrogen is still in its early stages, but existing energy policies provide a solid foundation for further development. Key regulations, such as Regulation No. 98 of 2021 on carbon pricing mechanisms and Law No. 3 of 2022 on National Strategic Projects, establish important principles for supporting clean energy investments, including hydrogen. However, dedicated hydrogen-specific regulations covering production, storage, transport, and safety standards will be crucial for project implementation and investor confidence. Further adjustments to Indonesia's carbon pricing mechanism, particularly the level of carbon tax rates, could enhance the competitiveness of green hydrogen relative to fossil-based alternatives, accelerating adoption across key industries. To support market development and international trade, Indonesia should ensure alignment with global hydrogen certification schemes, standards, and best practices. State-owned enterprises (SOEs), particularly Pertamina and PLN, are expected to play a central role in scaling up hydrogen projects, supported by targeted regulatory reforms. However, private companies can also contribute significantly to the growth of green hydrogen and should equally be considered in the regulatory framework.
- **Technology framework:** Indonesia's existing industrial base and energy infrastructure provide a strong foundation for hydrogen development. The country has well-established ammonia production facilities and a network of industrial ports that can be leveraged for hydrogen production and distribution. Several industries, including oil refining, petrochemicals, and fertilisers, are already potential off-takers for clean hydrogen. Pilot projects focused on off-grid renewable hydrogen production could help assess scalability and integration with Indonesia's broader energy system.

By establishing a clear policy and regulatory environment, leveraging existing infrastructure, and promoting technological innovation, Indonesia can position itself as a leading regional player in the green hydrogen economy, supporting both domestic industrial needs and future export opportunities.

4.2 Challenges and considerations

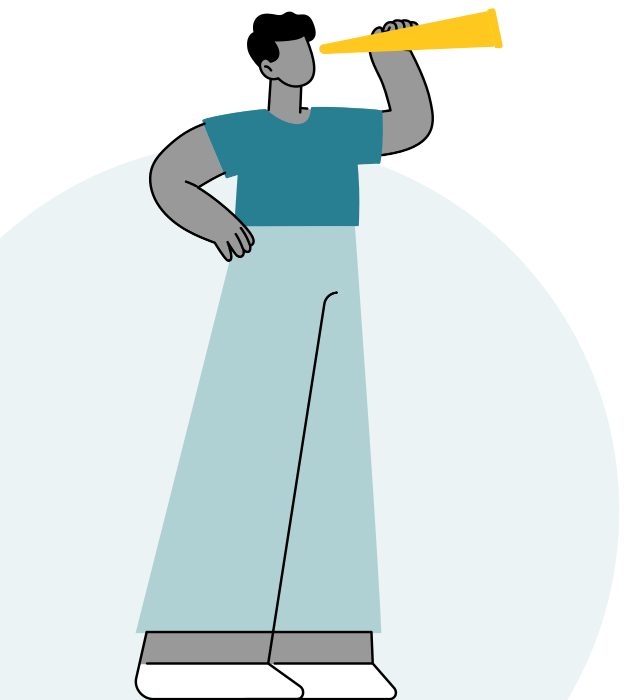
The implementation of green hydrogen technologies in Indonesia faces several challenges spanning economic, technical, and geographic terms. Significant barriers, which are prevalent globally and also relevant to Indonesia, include the absence of a clear regulatory framework, inadequate financial support or incentives, limited demand from buyers willing to pay a premium for green hydrogen, and the need for further development in hydrogen transportation technologies. Additionally, Indonesia's archipelagic geography complicates market integration at large scale, with potential generators and consumers in different locations. Addressing these challenges will require policy support, strategic investment, and public-private collaboration.

- **Economic challenges:** High production costs remain a significant barrier to green hydrogen adoption in Indonesia. While there are large industries with potential demand, the local availability of abundant and low-cost fossil resources such as natural gas hampers the competitiveness of green hydrogen. The willingness of industrial off-takers to pay a premium for green hydrogen remains unclear, further complicating the situation. Without large-scale, committed consumers, achieving economies of scale will be difficult.
- **Technical challenges:** Indonesia's reliance on coal for electricity generation and current low renewable energy installed capacity make it difficult for green hydrogen projects to rely on grid electricity, regardless of project size. There is a need for fully off-grid solutions, where green hydrogen production is directly powered by dedicated renewable energy sources. Additionally, Indonesia's geography complicates large-scale energy integration, making it challenging to connect hydrogen production sites with industrial off-takers. Another hurdle might be land availability, as large renewable energy installations would preferably be installed near industrial clusters for on-site hydrogen generation. Full off-grid solutions will also require dedicated energy storage systems for both electricity and hydrogen.
- **Regulatory challenges:** Indonesia's landscape for green hydrogen is still developing. The country has established several regulations and strategies related to renewable energy, including hydrogen. There are several strategies that are currently being worked on, such as the Roadmap for Hydrogen and Ammonia and the Government Regulation for Hydrogen. There are also current plans to develop further derivative regulations, such as the purchase of electricity from new energy sources to accommodate the purchase of electricity from hydrogen power plants. However, these strategies and regulations have not yet been finalised.

While Indonesia will encounter several challenges on its journey towards green hydrogen adoption, the nation possesses significant potential to lead the regional hydrogen market. By addressing critical issues related to policy, regulatory framework (including incentives and fiscal instruments), infrastructure, and financing, Indonesia can build on its existing efforts and strengthen its position as a leader in the Asian hydrogen economy.

4.3 Green hydrogen financing opportunities for German companies

The green hydrogen sector requires substantial financial investments to overcome high initial costs and infrastructure challenges. Several funding mechanisms exist to support hydrogen projects globally, particularly in emerging markets. These mechanisms are designed to reduce investment risks, facilitate project development, and encourage public-private partnerships.



GERMAN INSTRUMENTS FOR INVESTMENT IN THE INTERNATIONAL MARKET

- **H_2Global** (H_2Global Stiftung, 2025): A reverse auction-based mechanism to support green hydrogen market development, offering 10-year purchase agreements. No project size or investment limitations; non-EU hydrogen producers can participate, meeting EU sustainability standards.
- **PtX Development Fund** (KfW, 2025): Set up by the German Government and KfW Group. Provides non-reimbursable grants for large-scale projects in emerging economies, with no specific investment thresholds. Eligible countries include Brazil, Colombia, Egypt, India, Kenya, Morocco, and South Africa (PtX Development Fund, 2025). As of now, Indonesia is not listed among the eligible countries. However, eligibility criteria and target countries may evolve in future funding rounds.
- **International Hydrogen Ramp-up Programme** (H_2Uppp) (BMWK, 2025): Supports early-stage public-private partnerships for pilot projects, with a minimum public contribution of EUR 100,000 and total project costs of at least EUR 200,000. Companies must contribute at least 50%. Last call for applications closed in March 2025 (PtX Hub, 2025), though the overall programme is expected to continue until 2026 (BMWK, 2024).
- **UFK Untied Loan Guarantees** (UFK-Garantien.de, 2025): Provides loan guarantees to reduce political and economic risks in target countries. Green hydrogen projects may be eligible if they align with Germany's energy strategy.

European instruments for investment in the international market

- **Green Hydrogen Trust Fund (GHF)** (European Investment Bank, 2025): The European Investment Bank (EIB) established this fund to support large-scale green hydrogen infrastructure projects and to provide strategic advice and capacity building to developing countries. Indonesia is an eligible country to receive funding.
- **Clean Hydrogen Partnership (CHP)** (European Union, 2025): Primarily supports the development and commercialisation of clean hydrogen technologies. No fixed limitations on project size or investment, but large, impactful projects are prioritised. Eligible countries are EU member states and countries associated to Horizon Europe, which Indonesia currently is not (European Comission, 2024). It may therefore participate only through specific agreements/joint projects with EU member countries.

MULTILATERAL INSTRUMENTS

- **MIGA (Multilateral Investment Guarantee Agency)** (MIGA, 2025): Offers political risk insurance and credit guarantees for hydrogen investments in developing countries, with a focus on projects with significant developmental impact. There is no strict minimum investment amount, but larger projects, especially those aligned with national development priorities, are likely to be prioritised. MIGA funds investments into a developing member country made by investors located in any MIGA member country. Indonesia, together with 181 other countries, is one of the countries eligible for funding (World Bank Group).
- **Global Environment Facility (GEF)** (Green Climate Fund, 2025): Provides grants and concessional loans for renewable energy projects, including green hydrogen, to achieve decarbonisation and environmental goals.
- **World Bank Loans:** The World Bank promotes the implementation of renewable energy projects including hydrogen through various programmes and initiatives. In 2023, for example, the bank stated that it had approved USD 1.6 billion in funding for renewable hydrogen loans in that year (World Bank, 2023).
- **Asian Development Bank:** In 2022, the ADB established the Energy Transition Mechanism Trust Fund with resources to provide technical assistance, grants, or concessional financing for projects related to early retirement of coal-based generation assets and clean energy (ADB, 2025).
- **United Nations Industrial Development Organization (UNIDO) Accelerate-to-Demonstrate (A2D) Facility** (UNIDO, 2024): This is dedicated to accelerating the commercialisation of innovative climate solutions in developing countries. It focuses on providing grant funding to support the implementation and operation of demonstration projects, for instance for clean hydrogen and industrial decarbonisation projects. The programme supports pilot demonstration projects in developing countries, tests innovative production methods, validating efficiency and feasibility in real-world applications, and utilises grant funding and knowledge sharing to maximise clean hydrogen's potential.

PRIVATE FINANCE

- **Hydrogen One Capital** (HydrogenOne, 2025): A private venture fund specialising in direct or indirect investments in hydrogen infrastructure and technology.
- **Breakthrough Energy Ventures** (Breakthrough Energy, 2022): Through various programmes, Breakthrough Energy supports cutting-edge research and development by investing in companies with clean products to accelerate the clear energy transition.
- **Green Bonds:** These bonds are fixed-income financial instruments designed to fund sustainable projects such as renewable energies or clean transportation. There are different standards that can be applied, two of the most common being the Green Bond Principles issued by the International Capital Market Association (ICMA, 2025) and the Climate Bond Standards (Climate Bonds, 2025).

These mechanisms provide diverse funding options tailored to different stages of hydrogen project development, ensuring both public and private contributions to the sector's growth.

4.4 Stakeholder mapping and institutional overview

The development of Indonesia's green hydrogen sector will require the collaboration of various stakeholders, including government agencies, regulatory authorities, academic institutions, private sector players, non-governmental organisations, and international partners. Each of these groups will play a crucial role in shaping the policy landscape, advancing pilot projects, and developing the necessary regulations to enable the widespread adoption of hydrogen technologies. Key stakeholders involved in this process and their role related to hydrogen are listed in Table 13.

TABLE 13. Key Indonesian stakeholders for hydrogen development

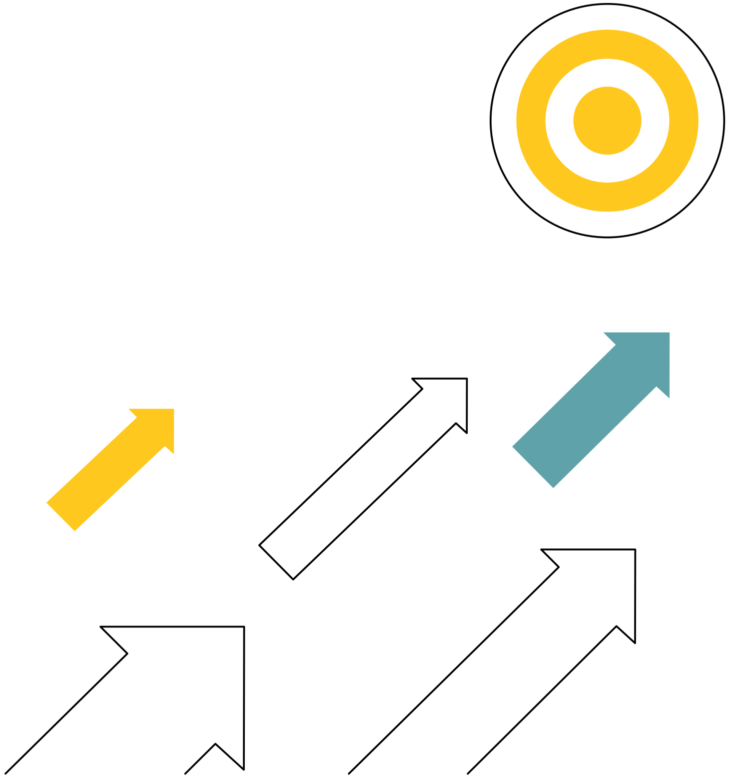
Institution	Role related to hydrogen
PUBLIC	
Ministry of Energy and Mineral Resources	The Ministry is responsible for formulating and implementing policies and regulations that regulate the exploration, production, and use of hydrogen in the country.
Ministry of Environment and Forestry	Responsible for environmental regulations and conservation efforts that impact hydrogen production and usage.
Ministry of National Development Planning	Develops strategies and policies for integrating hydrogen as a sustainable energy source in national development plans.
Ministry of Finance	Manages financial incentives, taxes, and funding for hydrogen-related projects and infrastructure development.
Ministry of Industry	Developing and/or bridging partnerships with industry and stakeholders
National Research and Innovation Agency (BRIN)	The agency is actively involved in advancing research and innovation for the development of a clean hydrogen industry.
National Standardization Agency of Indonesia (BSN)	Prepares and establishes Indonesian National Standards (SNI) that can be applied to various sectors; ensures that the standards applied in Indonesia are in line with international standards; cooperates with other authorised institutions such as Product Certification Institutions (LSP) and Management System Certification Institutions in the process of product and process certification in the green hydrogen industry
PT Pertamina	Pertamina is a state-owned oil and gas company in Indonesia, and is a key player in green industry. They are planning to invest USD 11 billion.
PT PLN	Indonesia's state-owned electricity company initiated the development of Indonesia's first green hydrogen plant in Jakarta and will play a major role in the implementation of further projects across the country.

Institution	Role related to hydrogen
NGO	
Indonesian Science Fund (DIPI)	DIPI actively promotes research and innovation in Indonesia by providing research grants in several key areas, including clean hydrogen, although the focus on hydrogen remains limited.
Hydrogen Energy Center Indonesia (HECI)	Hydrogen Energy Center Indonesia (HECI) was established in 2019 as the agent of change to promote the use of hydrogen as energy. HECI is a non-profit organisation run by volunteers who are acting on their commitment to a better energy future.
PRIVATE	
AHK Indonesia	The German-Indonesian Chamber of Industry and Commerce, known as EKONID or AHK Indonesia, serves as a strategic bridge between German and Indonesian businesses, facilitating bilateral trade and investment. In 2022 it established a Hydrogen Business Desk and launched the Hydrogen Indonesia information portal (Ekonid - AHK, 2022).
Indonesia Fuel Cell and Hydrogen Energy (IFHE)	Indonesia Fuel Cell and Hydrogen Energy is an association engaged in the field of fuel cells, hydrogen energy, and their applications. Since 2007, initial steps have been taken to introduce knowledge and technology related to fuel cells and hydrogen as a new and renewable energy source.
Industrial companies	Such as PT Kaltim Methanol Industri, PT Gunung Rajapaksi, PT Panca Amara Utama, etc.

Source: Authors' own compilation, Fichtner (2025)

4.5 Next steps for German companies

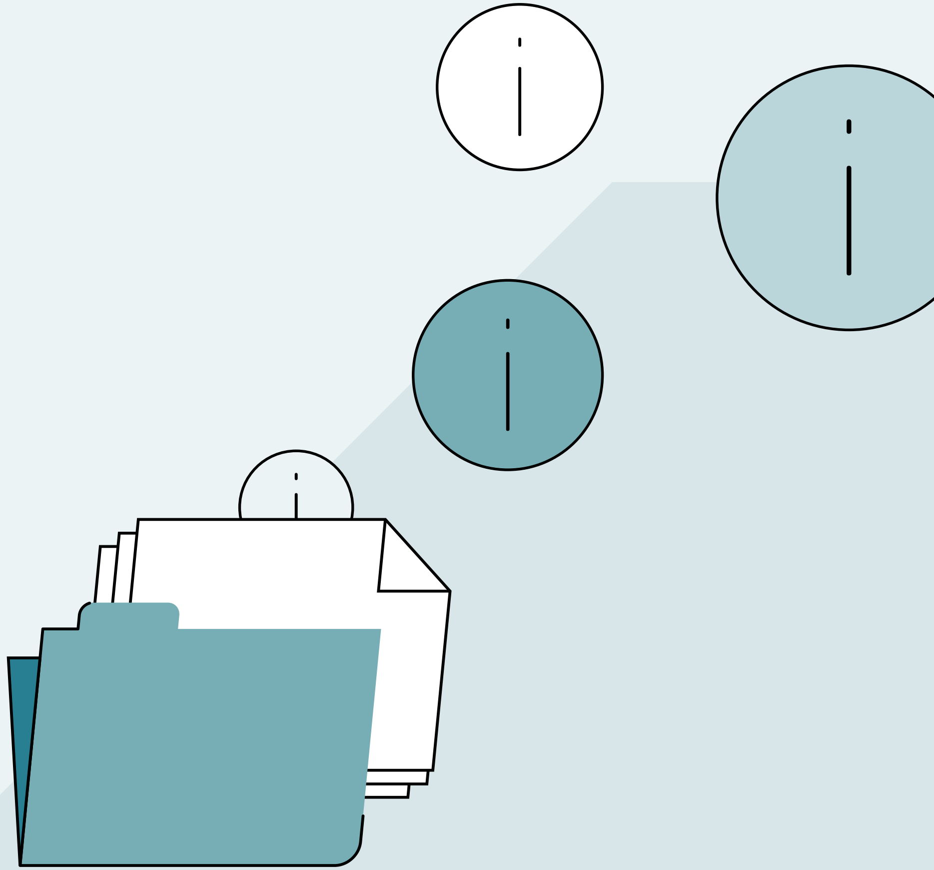
Indonesia offers substantial opportunities for German companies in the green hydrogen sector, bolstered by its renewable energy potential, strategic location, and increasing government focus on clean energy development. For German companies looking to participate in Indonesia's green hydrogen market, the following next steps are recommended:



1. Engage with local stakeholders: Partner with Indonesian government bodies, state-owned enterprises (Pertamina, PLN), and local industries (fertiliser, petrochemicals) to stay informed on policies and funding opportunities.
2. Leverage funding mechanisms: Explore financial instruments such as H_2Global and Green Hydrogen Trust Fund (GHF), as well as multilateral funding from World Bank and ADB, to reduce investment risks and support infrastructure development.
3. Assess market viability and infrastructure: Conduct feasibility studies on Indonesia's renewable energy capacity for hydrogen production and identify opportunities in key sectors (e.g. oil refining, fertiliser). Consider pilot projects to build local demand.
4. Monitor regulatory developments: Stay updated on the evolving regulatory landscape, incentives, and carbon taxes that might increase the competitiveness of green hydrogen projects.
5. Participate in pilot and R&D projects: Collaborate with local universities, research institutions, and private companies on hydrogen technologies to improve efficiency and scalability.
6. Explore export opportunities: Take advantage of Indonesia's strategic location and port infrastructure to position your project in the country as a competitive exporter of green hydrogen to regional markets such as Japan, South Korea, and Singapore.

By following these steps, German companies can establish a strong presence in Indonesia's green hydrogen market, benefiting from both domestic and export opportunities.

Annexes



Annex 1 Details of industrial clusters

Table 14 lists a selection of relevant industrial clusters across the country. The table is ordered alphabetically and includes the location of the clusters, the main sectors, key products, and main companies in each cluster. The H_2 column indicates clusters where grey hydrogen is likely to be required and, therefore, there is a potential for transitioning to green hydrogen.

TABLE 14. Main industrial clusters in Indonesia

	Industrial cluster	Location	Main sectors	Key products / Main companies	H_2
1	Batam	Batam, Riau Islands	Electronics, plastics and packaging, appliances	Electronics, packaging, rubber products, palm oil processing PT Infineon Technologies Batam, Simatelex, Shimano, Siix Electronics Indonesia, PT Epson Batam, PT Philips Industries Batam, PT WinWin Rubber Technologies, PT Synergy Oil Nusantara (Edible Oil), Musim Mas	×
2	Batang	Batang, Central Java	Glass, manufacturing	Float glass, rubber products KCC Glass, PT Nesinak Manufacturing Indonesia	×
3	Bekasi	Karawang, West Java	Automotive, chemicals, pharmaceuticals	Automotive parts, chemicals, ceramics PT Toyota Motor Manufacturing, PT Yamaha Motor Parts, PT Beta Pharmacon, PT Unilever Indonesia, Summit Adyawinsa Indonesia	
4	Bontang	Bontang, East Kalimantan	Fertilisers, methanol	Urea, ammonia, methanol, fertilisers PT Pupuk Kalimantan Timur, Kaltim Methanol Industri (KMI)	×
5	Cikarang	Bekasi, West Java	Chemical, automotive, electronics, glass, steel, food processing	Automotive parts, chemicals, electronics, steel products, glass PT Astra Honda Motor, PT Gunung Raja Paksi, PT Garuda Yamato Steel, PT Mulia Industrindo Tbk, PT AM/NS Indonesia, PT Evonik Indonesia, PT Kao Indonesia, PT Indofood Sukses, PT Wilmar Cahaya Kalbar	×

	Industrial cluster	Location	Main sectors	Key products / Main companies	H_2
6	Cikampek	West Java	Ammonia, fertilisers, mining, aluminium, chemicals, glass	Ammonia, fertilisers, NPK, explosives for mining, aluminium, chemicals, glass PT Pupuk Kujang, PT Multi Nitrotama Kimia (MNK), Alexindo CRC, PT Peroksida Indonesia Pratama, PT Asahimas Flat Glass	×
7	Cilegon	Cilegon, Banten	Steel, petrochemical, heavy industries, steel	Steel products, petrochemicals, plant equipment PT Krakatau Steel, PT Lotte Chemical, PT Chandra Asri, PT Indorama Polypet Indonesia, PT Asahimas Chemical	×
8	Gresik*	Gresik, East Java	Fertilisers, petrochemicals, copper	Urea, ammonia, ethylene, copper cathode PT Petrokimia Gresik, PT Smelting, PT Samator Intiperoksida, PT Wilmar Nabati	×
9	Lhokseumawe (Arun Lhokseumawe Special Economic Zone)	Aceh, Sumatra	Ammonia, fertilisers, oil & gas	Ammonia, fertilisers, LNG, oil products PT Pupuk Iskandar Muda, PT Humpuss Aromatik	×
10	Makassar	Makassar, South Sulawesi	Cement, food processing, shipping	Processed foods, cement, logistics Semen Tonasa, PT Indofood Sukses Makmur, PT Pertamina, PT Eastern Pearl Flour Mills Sea Side	
11	Morowali	Morowali, Central Sulawesi	Nickel mines, smelters, steel	Nickel metal, steel products Tsingshan Steel Indonesia, PT QMB New Energy Materials, Dexin Steel Indonesia, PT Merdeka Tsingshan Indonesia	
12	Palembang	Palembang, South Sumatra	Agriculture, fertilisers, oil	Palm oil products (cooking oil, biodiesel), urea, ammonia, oil products PT Musim Mas – Indokarya Internusa, Pertamina RU III Plaju, PT Pupuk Sriwidjaja Palembang, PT Sinar Alam Permai	×
13	Riau	Dumai, Riau, Sumatra	Palm oil, oil, petrochemicals, cement	Crude palm oil, biodiesel, processed oil products, cement PT Wilmar Nabati, Apical Group, Pertamina RU II Dumai, PT KLK Dumai, PT Pacific Indopalm, Musim Mas, Cemindo Gemilang, Taminas	×
14	Sei Mangkei	Simalungun, North Sumatra	Agriculture, food processing	Crude palm oil, processed foods, oleochemicals Unilever Oleochemical Indonesia, PT Sime Darby Oils, PT Industri Nabati Lestari	×

* Officially known as Java Integrated Industrial and Port Estate

Source: Authors' own compilation, Fichtner (2025)

Annex 2 Techno-economic calculations

TABLE 15. Techno economic calculations: Main parameters

Parameter	Value
Equity cost (%)	9.5
Debt interest rate (%)	6.3
Debt tenor (years)	10
Debt-to-equity ratio (%/%)	80/20
Inflation (%)	2.1
H_2 price increase above inflation (%)	2
Project lifetime (years)	25
CAPEX electrolyser (USD/kW)	Large-scale projects: 2,300 Small-scale projects: 2,700
CAPEX PV (USD/kWp)	Large-scale projects: 490 Small-scale projects: 540
CAPEX Wind (USD/kWp)	Large-scale projects: 1,600 Small-scale projects: 2,100

Parameter	Value
Geothermal PPA cost (USD/kWh)	9.5
Electricity price (USD/kWh)	0.07
Water cost (USD/ton)	2
Grey hydrogen benchmark price (USD/kg)	4.3
Oxygen selling price (USD/kg)	0.16
Ammonia price (USD/kg)	0.6
Corporate tax rate (%)	22

Source: Analyses performed by GIZ (2025)

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