INDONESIA – JAPAN COLLABORATION ROADMAP FOR ACCELERATING A HYDROGEN AMMONIA SOCIETY IN INDONESIA (HASI)

February 2026

This roadmap has been created with the expectation that it will be revised in the future.
The information contained herein is current as of 2026 based on the results of "Data collection survey for promoting a hydrogen society in Indonesia" conducted by JICA.
We recommend checking for the latest information as needed.

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BACKGROUND

Various efforts to promote an energy transition are underway in Indonesia, with hydrogen and ammonia positioned as promising options for achieving this goal.

In April 2025, the "Roadmap Hydrogen and Ammonia National (RHAN)" was officially released by the Ministry of Energy and Mineral Resources as Indonesia's strategic document to guide the long-term development of a low-carbon hydrogen and ammonia ecosystem.

The roadmap articulates a clear national vision: to establish hydrogen and ammonia as key enablers of industrial decarbonization, clean energy utilization, and green economic growth, while positioning Indonesia as a regional production and export hub by 2060. It outlines a phased pathway for commercialization, specifying hydrogen and ammonia demand targets and use cases across multiple sectors—including transportation, power generation, industrial processes (e.g., steel, fertilizers, and chemicals), and city gas networks.

On the other hand, Japan established the world's first national "Basic Hydrogen Strategy" in December 2017 to accelerate deployment across mobility, power, and industry, anchored in the 2050 carbon neutrality goal. In June 2023, the government set quantified mid-term targets—about 12 million tons of hydrogen (including ammonia) by 2040—alongside long-term cost goals, safety measures, and GX-aligned support to build domestic and international supply chains. To bridge commercialization gaps, Japan introduced multi-year price gap support and project approvals under the "Hydrogen Society Promotion Act "(enforced Oct. 23, 2024) to de-risk large-scale supply of low-carbon hydrogen and derivatives and mobilize public–private investment.

Japanese enterprises also see the challenge of the energy transition in Indonesia as an investment and business opportunity and accelerate their business development activities. Japanese enterprises have strong competitiveness in their technology and knowledge in hydrogen and ammonia areas which could contribute to the development of a hydrogen ammonia society in Indonesia.

INDONESIA'S HYDROGEN STRATEGY & ROADMAP

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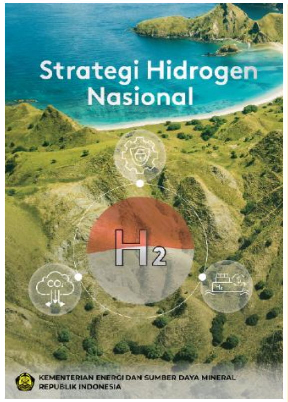
National Hydrogen Strategy (SHN)



The SHN document covers the current state, direction and goals of hydrogen development in Indonesia. The type of hydrogen to be developed in the initial stage is low-carbon hydrogen which is gradually targeted at zero carbon. The document can be downloaded from: https://bit.ly/StrategiHidrogenNasional

Objective:

"to establish a hydrogen economy that contributes to the energy transition and plays an essential role in decarbonizing the global energy system"

1. Indonesia will reduce dependence on fossil fuels to ensure sovereignty and security of energy
2. Indonesia will pursue its decarbonization target by developing the domestic hydrogen market
3. Indonesia will export hydrogen and its derivatives to the global market by taking advantage of its uniqueness as a maritime country

Outcome

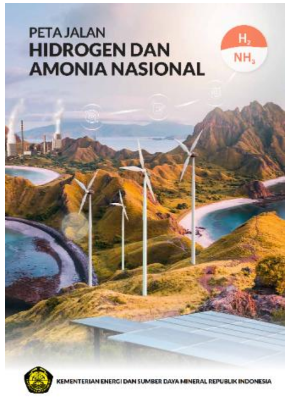
NZE target achieved	High NRE penetration	High foreign investment in green industry
Creation of green jobs	Universal energy access meets SDGz 7 criteria	Exports of low-carbon hydrogen and ammonia increased

Low-carbon Hydrogen and Ammonia Development Focused on 4 Sectors in Indonesia

1. Industry
2. Transportation
3. Electricity
4. As an export commodity

SHN was launched on
15 December 2023

National Hydrogen and Ammonia Roadmap (RHAN)



The RHAN document detailed action plan, as well as hydrogen development targets until 2060. The document can be downloaded from: https://www.esdm.go.id/assets/media/content/content-peta-jalan-hidrogen-dan-amonia-nasional

Objectives:

- Integrating SHN with hydrogen and ammonia development plans by various stakeholders
- Presenting projections for hydrogen and ammonia demand that support energy transition and integrating them into the national energy system
- Accelerating the development of a sustainable hydrogen and ammonia ecosystem
- Accelerating green economic growth

The development of H_2 and NH_3 in Indonesia is divided into 3 phases:

SHORT TERM (Initiation Phase: 2025-2034)
Initiate the development of low-carbon hydrogen while waiting for optimal economic viability to be achieved.

MEDIUM TERM (Development and Integration Phase: 2035-2045)
Balance between low-carbon hydrogen and high-carbon hydrogen. Green hydrogen begins to be implemented significantly as part of the transition to clean energy.

LONG TERM (Acceleration and Sustainability Phase: 2045-2060)
Green hydrogen dominates, low-carbon hydrogen declines, and high-carbon hydrogen is no longer used.

*RHAN was launched on **15 April 2025** at the GHES 2025 event.*

SUMMARY OF RHAN : HYDROGEN DEMAND BY SECTORS UNTIL 2060

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	2025–2034 (Initiation)	2035–2045 (Development and Integration)	2046–2060 (Acceleration and Sustainability)

Transportation

- 2025–2030: HRS pilot & commercialisation projects and FCEV pilot & commercialisation projects (0-3,000 units)
- 2031–2040: Commercialisation project of FCEV cars with a total of 3,000 - 115,128 units
- 2041–2051: Number of FCEV cars 115,128 - 1,108,411 units
- 2052–2060: Number of FCEV cars 1,108,411 - 3,633,120 units
- 2041–2051: Fuel cell train pilot project
- 2052–2060: Optimisation and continuous improvement of fuel cell technology for electric vehicles
- 2025–2034: Pilot and commercialisation projects for buses and heavy-duty trucks
- 2035–2040: Initiation of H_2 utilisation in trains and ships
- 2041–2051: Development of hydrogen use fuel cell-based marine transport

0 – 3,690 tonnes/year | 3,690 – 73,199 tonnes/year | 73,199 – 985,230 tonnes/year

Gas Network

- 2028–2034: H_2 blending: 20%
- 2035–2040: H_2 blending: 40%
- 2041–2046: H_2 blending: 60%
- 2047–2054: H_2 blending: 80%
- 2055–2060: H_2 blending: 100%

0 – 7,588 tonnes/year | 7,588 – 22,300 tonnes/year | 22,300 – 41,234 tonnes/year

Power Plant

- 2025–2034: Pilot demonstration trials for ammonia co-firing in power plants at 3-30%, and hydrogen co-firing in gas turbines at 3-10%
- 2035–2045: Ammonia power plants: 2 GW, co-firing in CPP at 60-100%, and hydrogen co-firing in gas turbines with a percentage of 30-60%.
- 2046–2060: Ammonia power plant: 2-8.4 GW, Hydrogen plant: 0-25.3 GW CPP using 100% ammonia, and hydrogen co-firing in gas turbines with a percentage of 60-100%.
- 2027–2034: Initiation of hydrogen fuel cell for hybrid generation for dedieselisation program at 0-10%
- 2035–2045: Commercialisation of hydrogen fuel cell program for hybrid power generation for dedieselisation program with a percentage of 10-20%.
- 2046–2053: Development of hydrogen fuel cell program for hybrid power generation for dedieselisation program with a percentage of 20-25%
- 2054–2060: Development of hydrogen fuel cell program for hybrid power generation for dedieselisation program with a percentage of 25-40%

919 - 88,690 tonnes/year | 88,690 - 444,470 tonnes/year | 444,470 - 4,221,429 tonnes/year

Industry

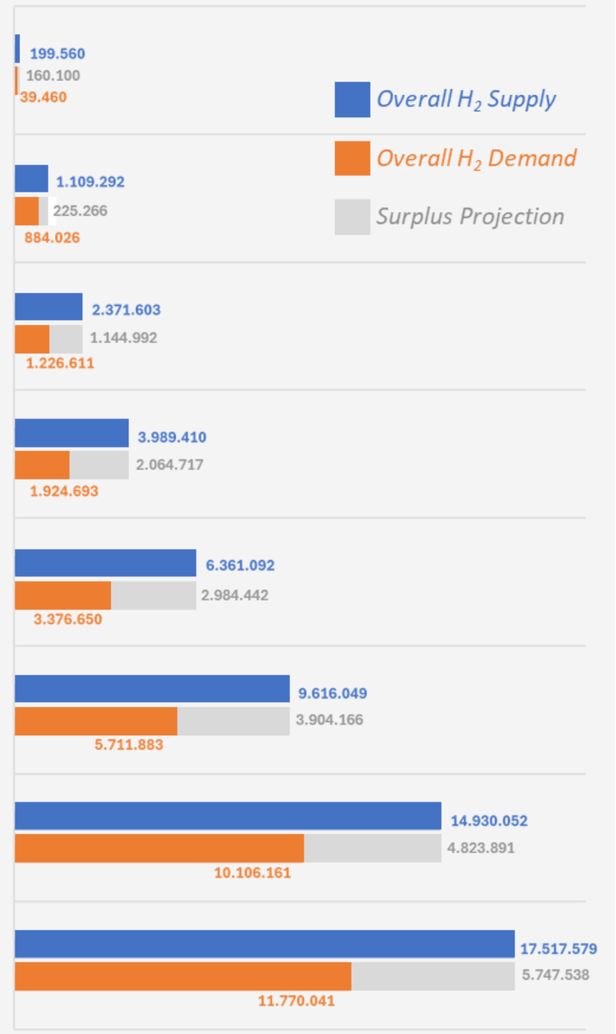
- 2025–2040: Initiation of clean hydrogen utilisation in the steel industry and refinery sector
- 2041–2060: Implementation of clean hydrogen in textile, pulp and paper, food and beverage industries
- 2035–2060: Implementation of clean hydrogen in chemical industry (methanol, ammonia)
- 2026–2060: Implementation of clean hydrogen in the fertiliser industry

38,541 - 1,126,644 tonnes/year | 1,126,644 - 2,836,681 tonnes/year | 2,836,681 - 6,522,148 tonnes/year

Total

39,460 -1,226,611 tonnes/year | 1,226,611 - 3,376,650 tonnes/year | 3,376,650 - 11,770,041 tonnes/year

Overall H_2 Supply - Demand



SUMMARY OF RHAN : HYDROGEN & AMMONIA IMPLEMENTATION STRATEGY

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Implementation Strategy

a series of steps or phases systematically designed to achieve the long-term goals set out in the National Hydrogen Strategy

SHORT TERM 2025 – 2034
(Initiation Phase)

- Development of a comprehensive national low- carbon hydrogen & ammonia strategy and roadmap for Indonesia
- Implementation of feasibility studies for the production, storage, transportation, and use of low-carbon hydrogen & ammonia
- Initiation of pilot low-carbon and/or green hydrogen & ammonia projects
- Development of low-carbon hydrogen & ammonia regulations including standards and certifications
- Development of incentive and carbon trading schemes for the development of low-carbon hydrogen & ammonia
- Initiation of commercialization of low-carbon and/or green hydrogen & ammonia
- Initiation of financing scheme for low carbon hydrogen & ammonia project investment
- Initiation of research and development of domestic hydrogen & ammonia supply chain infrastructure
- Initiation of international partnerships for knowledge sharing and collaboration
- Capacity and competency development of personnel

MEDIUM 2035 – 2045
(Development and Integration Phase)

- Evaluation of progress and enhanced monitoring of roadmap implementation
- Preparation of studies to improve the integration of hydrogen & ammonia infrastructure to achieve efficiency and sustainability.
- Increased investment in green hydrogen infrastructure and storage facilities, and a national network of hydrogen filling stations for transportation.
- Development of policies to accelerate the utilization of green hydrogen & ammonia.
- Development of incentive schemes and carbon trading for green hydrogen & ammonia development.
- Increased use of green hydrogen & ammonia in the industrial, power generation, city gas network and transportation sectors.
- Increased investment in green hydrogen & ammonia
- Mainstreaming of domestic hydrogen & ammonia supply chain infrastructure technology innovation to achieve efficiency
- Indonesia becomes a low-carbon hydrogen & ammonia hub in ASEAN.
- Capacity and competency improvement of personnel

LONG TERM 2045 – 2060
(Acceleration and Sustainability Phase)

- Progress evaluation and strengthened monitoring of roadmap implementation.
- Increased investment in integrated green hydrogen & ammonia supply chain infrastructure to achieve economics, sustainability, national technological independence, and Indonesia's competitiveness at the global level.
- Play an active role in forging international partnerships to strengthen Indonesia's role in the global green hydrogen supply chain.
- Achieve Indonesia's position as one of the important green hydrogen & ammonia players in the global market.

Source: Shared by MEMR

JICA's DATA COLLECTION SURVEY FOR PROMOTING A HYDROGEN SOCIETY IN INDONESIA

In November 2022, PLN and JICA signed a Memorandum of Cooperation (MOC) to accelerate Indonesia's energy transition. In May 2024, MEMR, BRIN, IFHE, and JICA signed an MOC for partnership to promote the development of hydrogen and ammonia society in Indonesia. In August 2024, Pertamina and JICA signed Letter of Intent (LOI) to enhance energy transition in Indonesia. Additionally, in October 2025, JICA signed an MOC with Pupuk to promote the development of clean ammonia value chains.

Based on these agreements, JICA started **"Data collection survey for promoting a hydrogen society in Indonesia"** from November 2024 to February 2026.

The goal of the survey is to develop a roadmap for the Indonesia-Japan Hydrogen and Ammonia Partnership.

The following three work streams were conducted during the roadmap development process:
(1) Value chain analysis to identify and evaluate promising model cases in Indonesia
(2) Identification of key bottlenecks and actionable pathways toward market creation
(3) Public and private stakeholder engagement

As the final output of the survey, MEMR and JICA co-published the "INDONESIA – JAPAN COLLABORATION ROADMAP FOR ACCELERATING A HYDROGEN AMMONIA SOCIETY IN INDONESIA" (HASI) .

JICA's PARTNERSHIP RELATED TO ENERGY TRANSITION IN INDONESIA

MOC with PLN to promote energy transition (2022.10)

PLN

MOC with MEMR, BRIN, and IFHE on the promotion of new energy (hydrogen and ammonia) (2024.5)

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BRIN
BADAN RISET DAN INOVASI NASIONAL

IFHE

LOI with Pertamina to promote energy transition (2024.8)

PERTAMINA

MOC with Pupuk to promote clean ammonia value chain development(2025.10)

PUPUK INDONESIA
HOLDING COMPANY

PURPOSE

"INDONESIA – JAPAN COLLABORATION ROADMAP FOR ACCELERATING A HYDROGEN AMMONIA SOCIETY IN INDONESIA (HASI)" is published to accelerate Indonesia-Japan and public-private partnerships towards the realization of hydrogen ammonia society in Indonesia.

The roadmap outlines the Indonesia-Japan collaboration strategy, which is aligned with RHAN. It establishes the direction of the 3 phases (IN, PI, AB) and the timing of commercialization of each application.

Based on the results of the analysis in terms of key challenges of a hydrogen and ammonia society in Indonesia, as well as the initiatives of the Japanese and Indonesian public and private sectors, eight areas of strategic collaboration between Indonesia and Japan have been identified. The collaboration concept, impact and key challenges, timeline, and collaboration idea in the IN phase have been established for each area.

The roadmap aims to bridge the policy goals of RHAN with executable projects by establishing a shared understanding of the bottlenecks and necessary actions required to create a hydrogen ammonia society in Indonesia. It delineates joint workstreams for technology and supply chain development, certification and safety rule-making, and economic incentive design, including ammonia and other hydrogen derivatives.

From the perspective of stakeholders in Indonesia, this roadmap will facilitate the further involvement of Japanese public and private sectors. Conversely, from the perspective of Japanese companies, it will serve as a guide for investment and further cooperation with Indonesia.

POSITIONING OF "INDONESIA – JAPAN COLLABORATION ROADMAP FOR ACCELERATING A HYDROGEN AMMONIA SOCIETY IN INDONESIA(HASI)" FOR "RHAN"

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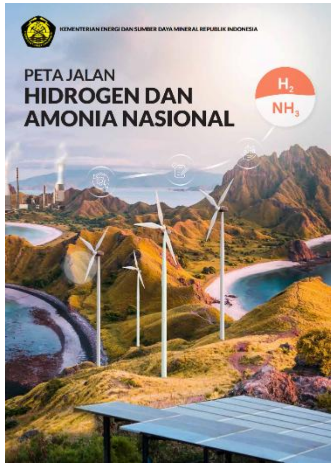
"Roadmap Hydrogen and Ammonia National (RHAN)



Indonesia's strategic document to guide the long-term development of a low-carbon hydrogen and ammonia ecosystem

Supplement how to achieve RHAN

INDONESIA – JAPAN COLLABORATION ROADMAP FOR ACCELERATING A HYDROGEN AMMONIA SOCIETY IN INDONESIA（HASI）

Final Documents

INDONESIA – JAPAN COLLABORATION ROADMAP FOR ACCELERATING A HYDROGEN AMMONIA SOCIETY IN INDONESIA (HASI)

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GUIDEBOOK FOR FUTURE COLLABORATION WITH JAPAN

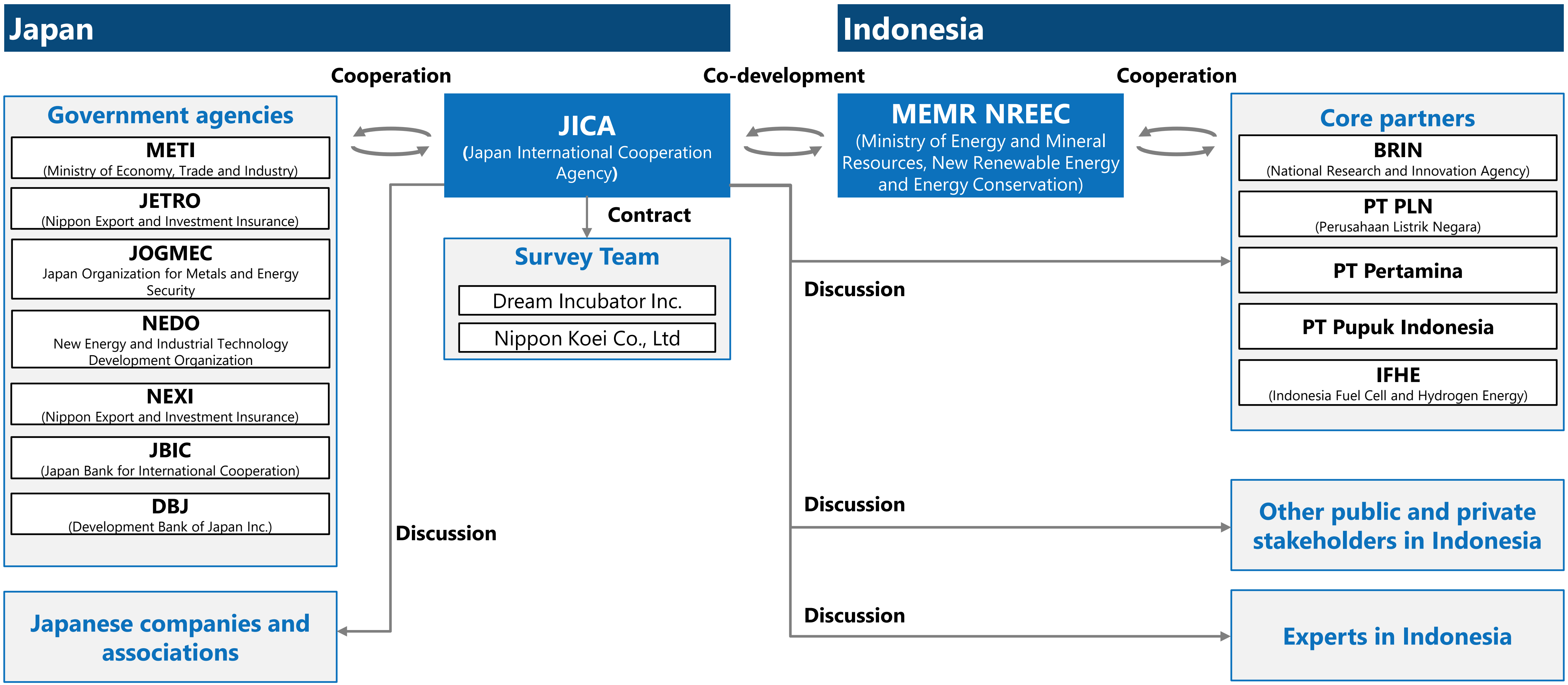
Survey Process

- ✓ **Survey of the Latest Trends in Promoting a H_2 and NH_3 Society**
- ✓ **Formulation of Conceptual Model**
- ✓ **Impact & Key Challenges**
- ✓ **Identification of Key Measures**

Platform Activities

Organization of workshops, forums, and Japan visits to strengthen stakeholder relationships

TEAM STRUCTURE FOR FORMULATION OF THE ROADMAP



APPROVAL PROCESS FOR PUBLICATION

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Basic Survey

Basic analysis on promising models in Indonesia

- Analysis on bottlenecks and impacts

Platform Activities

A series of forums and workshops to confirm the potential of hydrogen and ammonia to identify the bottlenecks and to find potential solutions.

Collaboration Roadmap Formulation

The draft collaboration roadmap is based on the results of the basic survey and the platform activities.

- JICA and its survey team drafted the collaboration roadmap, cooperating with Japanese government agencies.
- It was then discussed with MEMR and core partners in Indonesia and Japan.

Discussion with Multi-stakeholders

In-depth discussions with stakeholders across government, industry, and academia in both Indonesia and Japan contributed to the refinement of the collaboration roadmap.

- Key public and private stakeholders* in both Indonesia and Japan were interviewed.
- Consultations were held with academic experts.
- Workshops and seminars were held to collect feedback.

Internal Audit

Based on the results of discussions with multiple stakeholders, MEMR and JICA finalized the collaboration roadmap and proceeded with the internal publication process.

* A detailed list of interviewed stakeholders is provided in the Appendix.

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POTENTIAL OF THE HYDROGEN AND AMMONIA SOCIETY IN INDONESIA

Indonesia has the capacity to produce hydrogen and ammonia by utilizing its green energy sources.

There are multiple potential applications across energy and industrial sectors. The listed potential applications are mainly based on RHAN, with some additions derived from JICA's analysis.

The expanded use of hydrogen and ammonia can enhance energy security, support decarbonization by reducing lifecycle emissions, and stimulate economic activity through investment, job creation, and technology transfer.

OVERVIEW OF THE INDONESIA – JAPAN COLLABORATION ROADMAP FOR ACCELERATING A HYDROGEN AMMONIA SOCIETY IN INDONESIA

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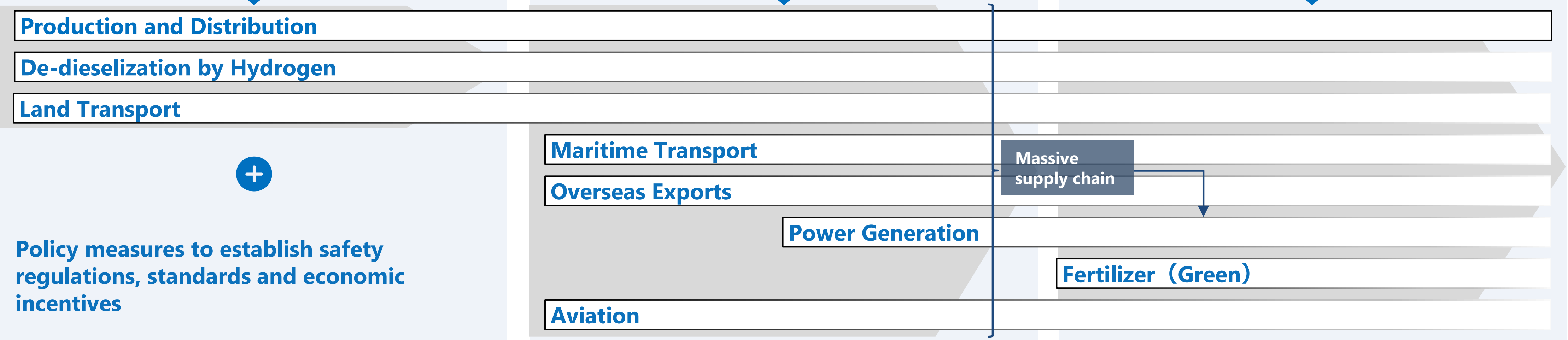
	Initiation Phase* (2025~2034)	Development and Integration Phase (2035~2044)	Accelerated and Sustained Phase (2045~2060)
Indonesia-Japan Collaboration Strategy	**Initiate social implementation with individual value chains and applications where the price gap with conventional fuels is relatively small.** • De-dieselization by Hydrogen: 1) Expensive diesel costs, 2) High grid maintenance costs. • Land Transport: 1)Expensive diesel costs, 2) Replicability of the incentive measures for EVs	**Develop large-scale and integrated value chains that align with maritime transport, aviation, and exports. All of these sectors must adhere to international rules.**	**Expand the domestic demand and ensure the sustainability of a hydrogen ammonia society.** • Leverage economies of scale to establish a self-sustaining hydrogen economy.
Cooperation from Japan	■ **Expertise in technologies** (e.g., fuel cells, ammonia synthesis, MCH,etc.) ■ **Collaboration in establishment of economic incentives and other system developments including safety standards**	■ **Collaboration in the development of large-scale integrated value chains** ■ **Financial support** ■ **Expertise in technologies** (e.g., fuel synthesis, related equipment)	■ **Expertise in technologies** (e.g., co-firing, mono-firing) ■ **Promoting sustainable private investment**

Strategic Collaboration Area**



* The timeline of the phases is aligned with RHAN.
** For the strategic collaboration areas, those with a high potential for collaboration with Japanese companies have been selected.

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DOCUMENT STRUCTURE

1st sheet **CONCEPT PAPER**	This sheet outlines concepts for strategic collaboration areas between Japan and Indonesia. It addresses how hydrogen and ammonia can contribute to Indonesia's energy transition challenges. Specifically, it presents envisioned concepts, promising candidate locations for implementation, and exemplary initiatives that should be monitored to promote collaboration.
2nd sheet **IMPACT & KEY CHALLENGES**	This sheet illustrates the estimated quantitative impacts of strategic collaboration area in terms of (1)energy security, (2)carbon neutral, and (3)economic impact for the year 2035. Note that this calculation is fundamentally linked to the quantitative targets outlined in the RHAN. Furthermore, it identifies bottlenecks from the perspectives of technology, infrastructure, standards/safety, and economic incentive design in realizing each strategic collaboration area.
3rd sheet **TIMELINE**	This sheet chronologically presents the state required to achieve the quantitative targets and commercialization timelines outlined in the RHAN for the strategic collaboration areas. These analyses are based on the analysis of key challenges presented in the second sheet.
Final sheet **COLLABORATION IDEA IN THE INITIATION PHASE (2025-2035)**	This sheet outlines collaboration ideas between Japan and Indonesia during the Initiation Phase (2025-2035) defined in RHAN. It specifies the outcomes required to achieve the desired state in the Initiation Phase, organizes potential project concepts to achieve those outcomes, and identifies collaborative actions for Japan and Indonesia.

STRATEGIC COLLABORATION AREA

PRODUCTION AND DISTRIBUTION

CONCEPT PAPER

Background and Issues

Indonesia remains heavily reliant on fossil fuels and has not yet been able to fully utilize its renewable energy potential.

- Indonesia consumes **1.75Mt of H_2/year** and most of them are grey H_2 derived from fossil fuels.
- Despite **3,689 GW** of renewable energy potential, only **0.3%** is currently utilized.
- Fossil fuels still account for **86.71%** of total energy supply. (Coal: 39.69%, Petroleum: 29.91%, Natural gas: 17.11%, Renewable energy: 13.29%)

Potential of H_2 and NH_3

Converting surplus electricity into hydrogen H_2/NH_3 could contribute to decarbonization, improve energy security, and boost economic efficiency.

- Both H_2 and NH_3 have various applications in fuel and industrial uses.

H_2 and NH_3 are also expected to be utilized as energy carriers.

- Transporting H_2/NH_3 to remote islands and isolated areas could potentially reduce grid maintenance costs.
- (However, infrastructure costs for H_2/NH_3 must be considered.)

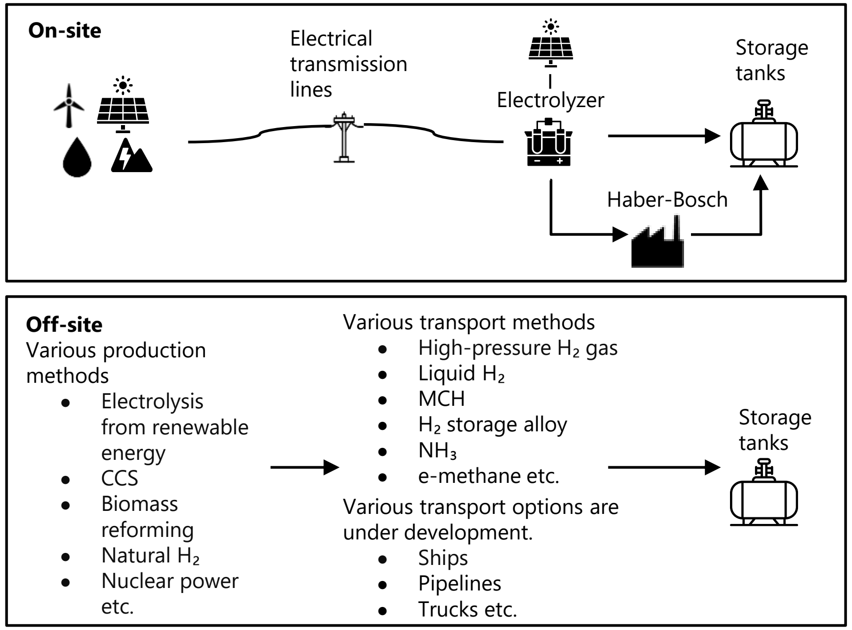
Concept

Overview

Hydrogen and ammonia produced with zero or very low CO_2 emissions

- It is possible to transmit renewable energy to the demand site and produce H_2 with electrolyzers.
- Various production methods are possible, including CCS, biomass reforming and use of nuclear energy.
- Various transport methods are possible, including high-pressure H_2 gas, liquid H_2, MCH, H_2 storage alloy, NH_3.

Image



Facility

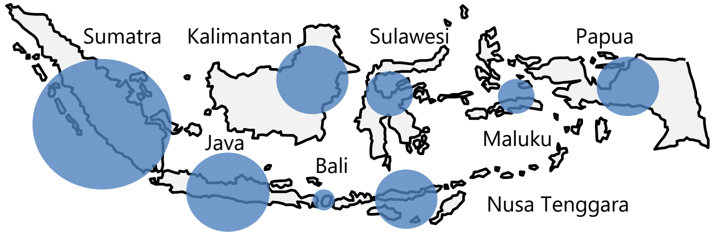
- Electrical transmission lines
- H_2/NH_3 production facilities (Electrolyzers etc.)
- H_2/NH_3transport facilities (Ships, pipelines and trucks etc.)

Potential Place

Renewable-rich areas

- Renewable energy remains underutilized due to supply instability and lack of infrastructure.
- The distance from demand areas should also be considered.
- Geothermal (Bali/Sumatra)／Hydro (Sumatra/Kalimantan)／Solar (Bali/Nusa Tenggara)／Wind (South Sulawesi)

Potential of renewable energy*



Other production methods may also have different potential, but renewable energy is presented here as an example.

Benchmarks

Source : PT Pupuk Kujang HP

Cikampek Ammonia Production Pilot Project

Development of a project producing clean ammonia from clean energy, integrated with existing conventional production systems

Source : Pertamina, "Hydrogen Projects Initiative by Pertamina 2025"

Ulubelu Hydrogen Production Plant

Development of a 100 kg/day green hydrogen pilot plant using geothermal electricity and Anion Exchange Membrane (AEM) electrolyzers.

* Based on DEN's "Indonesia Energy Outlook 2023," the introduction potential of hydrogen from renewable energy sources is referenced.

Sources : S&P Global, "Indonesia's national hydrogen strategy sets stage for pilot projects, new investment", MEMR, "HANDBOOK OF ENRGY&ECONOMIC STATISTICS OF INDONESIA 2023", Mitsubishi Research Institute, "Indonesia's Power Sector Investments: Insights on sustainability from Japan (Part Ⅱ)", Petromido.COM, "Indonesian Hydrogen Outlook 2024", Pertamina, "Hydrogen Projects Initiative by Pertamina 2025", MEDIA INDONESIA, Pupuk Kujang Cikampek Produksi Green Ammonia untuk Energi Bersih PLTU, DEN, "Indonesia Energy Outlook"

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KEY CHALLENGES

Key Challenges and Requirements*

	Production	Distribution (Transport and Storage)
Technology	**Each production method needs technological development.** • Electrolyzers need **cost reduction.** • CCS requires development for **scaling and reliable CO_2 leakage monitoring.** • Methane-to-H_2 conversion needs **efficiency improvement.** • **Nuclear-based H_2 via chemical decomposition is still experimental.** • Natural hydrogen lacks **reserve estimation technology.** • Biogas reforming requires **high temperatures, raising costs.** • NH_3 production **faces technical challenges in energy efficiency and cost reduction** because the Haber-Bosch process requires high pressure and high temperature, leading to large energy consumption.	**Each distribution method needs technological development.** • High-pressure H_2 is mainstream, but **insufficient to transport.** • Liquid H_2 requires **high cooling energy.** • MCH requires **high-temperature heat**, and **the integration of technologies** has not yet been achieved. • H_2 storage alloys have low weight efficiency. • NH_3 use is restricted by toxicity. • Pipeline retrofitting is limited, including **leak detection and embrittlement prevention.** • Truck transport is **currently inefficient.**
Infrastructure	**Scaling and cost reduction are the main challenges.** • **Large-scale renewable plants and electrolyzers** have not yet been built. • **Large-scale CO_2 storage facilities** are under construction. • Regarding clean H_2/NH_3 production, **high-capacity electrical transmission lines from renewable-rich areas to on-site production site are needed.** • **Smart grid management** is needed.	**Infrastructure such as pipelines, H_2/NH_3 transport ships and H_2/NH_3 transport trucks** has not been fully developed. **Large-scale electrical transmission lines to deliver renewable energy to hydrogen demand centers** have not been constructed for reasons such as cost. Based on the characteristics of H_2 and NH_3, it is necessary to examine the economics and safety of **storage.**
Safety and Standards	**Standards, systems and frameworks for low-carbon H_2 are not yet established.** • Life cycle assessment • MRV system (Monitoring, Reporting, Verification)	**Safety standards for high-pressure hydrogen and ammonia are in place but may be revised if necessary.**
	Comprehensive regulations for H_2 and NH_3 are required. (spans both)	
Economic Incentive	**CAPEX support for infrastructure has not yet been established. (Subsidies, Low-interest loan)** **Financial support throughout the supply chain has not yet been developed.** • The price gap between clean H_2(3~8 USD/kg) and grey H_2(0.5~1.7 USD/kg) will be 2.5~6.3 USD/kg. • Financial penalties including carbon taxes should also be taken into account. (spans both)	

* The impact analysis is explained in the other strategic collaboration areas because the impact is included in each area.
Sources : IEA, "Global Hydrogen Review 2021" The price gap analysis are based on JICA consultant team's assumptions and calculations.

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TIMELINE

	2025–2030	2030–2035	2035–2040	2040–2045
	Initiation Phase		Development and Integration Phase	
Technology	**Production**			
	Clean H_2* : ~377,198 t	**Clean H_2 : ~1,453,372 t**	**Clean H_2 : ~2,885,037 t**	**Clean H_2 : ~5,070,580 t**
	Clean NH_3 : ~500,563 t**	**Clean NH_3 : ~631,563 t**	**Clean NH_3 : ~ 1,037,361 t**	**Clean NH_3 : ~1,486,987 t**
	Electrolyzer capacity : ~734MW	**Elctrolyzer capacity : 734MW~15GW**		**Electrolyzer capacity : 15GW~**
	Electrolyzers : Scale-up and cost reduction, CCS : Development of large-scale CO_2 storage facilities and detection systems			
	Development of other clean H_2 technologies		Commercialization of other technologies as they reach maturity	
Infrastructure	**Distribution (Transport and Storage)**			
	High-pressure H_2 : Improved transport efficiency and short-distance delivery			Scale up and cost reduction of H_2 transport (Liquid H_2/MCH/H_2 storage alloy/NH_3)
	Technology development of H_2 carrier Liquid H_2 : Efficiency improvement in cooling energy consumption MCH : Enhanced energy efficiency (High-temperature is required) H_2 storage alloy : Improved transport efficiency per weight NH_3 : Technology development to address toxicity and odor issues			
	Construction of electrical transmission lines from renewable-rich areas to H_2 demand areas		Scale-up of electrical transmission lines and improvement of transmission efficiency	
	Deployment of H_2 distribution facilities at ports (H_2 transport ships, tanks, pipelines, trucks etc.)		Scale-up of H_2 export facilities at ports (H_2 transport ships, tanks, pipelines, trucks, etc.)	
Safety and Standards	**Development of Quality Standards** Establishment of low-carbon H_2 standards (Life cycle assessment, MRV system)		**Operation and Revision of Standards** Standards are reliably implemented under appropriate monitoring and are regularly revised based on operational feedback.	
	Establishment of Comprehensive Regulations for H_2 and NH_3			
Economic Incentive	**Development of Financial Support (CAPEX Support for Infrastructure Including Subsidy and Concessional Finance , OPEX Support for Clean H_2 Production, and Financial Penalties)**			

* The sum of RHAN's clean hydrogen production targets for technologies with proven maturity, specifically electrolysis and CCS.
** Expressed in terms of hydrogen demand required for clean ammonia production.
Source : RHAN for firgures

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COLLABORATION IDEA IN THE INITIATION PHASE (2025-2035)

Directions of Initiatives in the Initiation Phase to Achieve RHAN Targets

RHAN aims to significantly scale up production of clean hydrogen and ammonia.

- Hydrogen supply by electrolysis: **199,560 t (2030), 355,851 t (2035)**
- Hydrogen supply by CCS: **21,347 t (2030), 42,693 t (2035)**
- Clean ammonia (in terms of required hydrogen input): **500,563 t (2030), 631,563 t (2035)**

To achieve this target, the Initiation Phase must ensure the commercialization of individual supply chains and the establishment of policy measures to set safety standards and economic incentives.

- It is essential to rapidly establish both demand and supply and achieve commercialization even on a small scale through capital support for production and distribution.
- Toward large-scale commercialization in the next phases, an policy framework must be in place and partially implemented during the Initiation Phase.

Hypotheses for Collaborative Initiatives in the Initiation Phase

	Commercialization of individual supply chains	Establishment of systems for the subsequent phases	Next Phases
Outcome	**Hydrogen production and transportation infrastructure deployed at selected locations, achieving economic viability through the supply chain**.	**Economic incentives and standards that enable long-term predictability should be established and partially enforced.** • Economic incentive design is indispensable for efficient hydrogen promotion in the next phases.	**The commerciali-zed model will be expanded nationwide in the Development and Integration, and Accelerated and Sustained Phases.**
Project Image	**Project to produce hydrogen onsite at demand areas through power transmission and transport it to nearby demand areas** • Existing hydrogen demand sites are a potential place.	**Project to design institutional frameworks from production to utilization** • Safety standards, economic incentives, life cycle assessment (LCA) , Monitoring/ /reporting/verification (MRV) system	
Initiatives Jointly Implemented by Indonesia and Japan	**Comprehensive policy framework** • Economic incentive design : Scope of support, types, and start/end dates • Standards establishment **Design of supply chains** • Selection of regions, hydrogen production methods, production sites, demand centers, and transport carriers **Knowledge sharing** • Installation, operation, maintenance of infrastructure		

Sources: RHAN (for figures), JICA consultant team's interview and analysis

STRATEGIC COLLABORATION AREA

DE-DIESELIZATION BY HYDROGEN

CONCEPT PAPER

Background and Issues

Many islands and remote areas lack grid electricity and rely on diesel generators.

- **High fuel transport and maintenance costs** place a burden on this system.
- Approximately **1,700 diesel plants** are under operation, and capacity is **588MW**. That accounts for 0.65% of power generation capacity.
- Diesel power plants emit approximately **2.15 times** as much CO_2 as grid-based electricity generation.
- In recent years, electricity demand has increased in islands and remote areas, while generation capacity remains limited.

Potential of H_2 and NH_3

Abundant renewable energy from nearby regions can be converted to H_2/NH_3 and transported with minimal additional cost – enabling decarbonization.

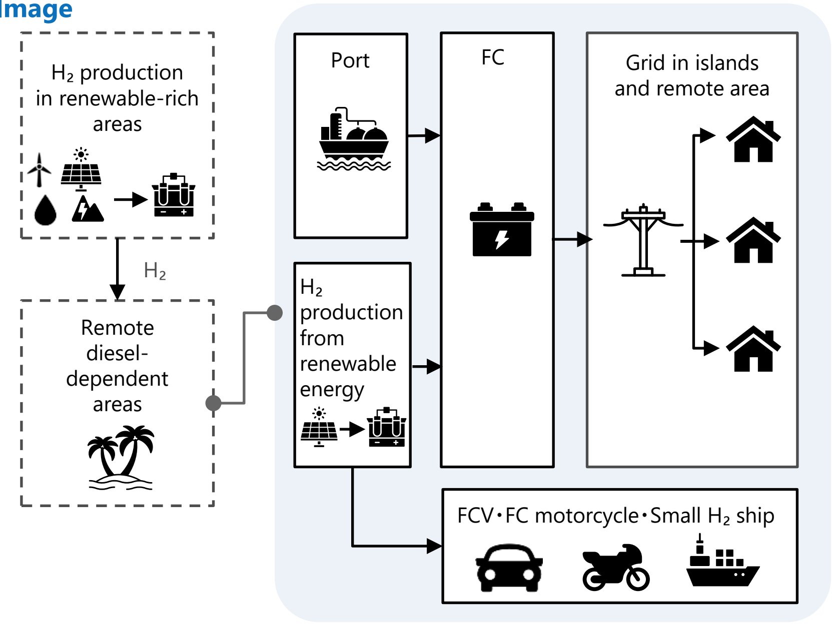
- H_2 serves as a clean fuel with zero carbon emissions at point of use.
- As an energy carrier, H_2 enables storage and balancing of intermittent renewables.
- H_2 power generation contributes to solve the electricity supply shortage in response to increasing power demand in island regions.
- It is necessary to examine comparisons, allocations, and combinations with other methods such as solar power.

Concept

Overview **Diesel to H_2/NH_3 transition in islands and remote areas**

- Both local production and external H_2 supply are considered.
- Effective utilization of surplus renewable energy enables decarbonization of remote areas through H_2/NH_3 use.

Image



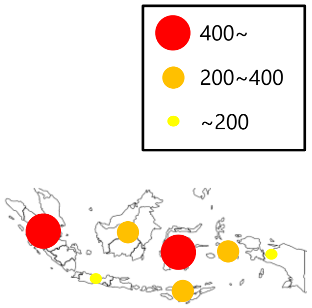
Facility

- H_2 transport vessels and tanks
- Receiving port facilities
- H_2 storage tanks
- Fuel cell power generation systems
- Fuel cell vehicles and motorbikes
- Small H_2 ship

Potential Place

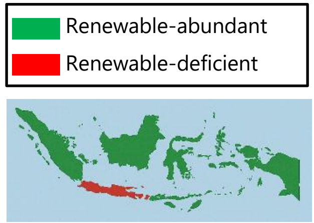
Remote diesel-dependent areas

- Due to their remote or island locations, these areas face technical challenges or unviable costs in connecting to the power grid, leaving them dependent on small-scale diesel power generation.
- These areas are distributed across multiple regions, including Sumatra, Kalimantan, Sulawesi, Maluku, Papua, Nusa Tenggara Barat, and Nusa Tenggara Timur.



Regions with surplus renewable energy

- Renewable energy remains underutilized due to supply instability and lack of infrastructure.
- Geothermal (Bali/Sumatra)
- Hydro (Sumatra/Kalimantan)
- Solar (Bali/Nusa Tenggara)
- Wind (South Sulawesi)



Benchmark

Gili Ketapang

Source : Photo by JICA consultant team

First H_2 power fed into Indonesia's grid

- Fuel cell system supplied by Toyota
- Current generation capacity covers 20% of total island demand
- H_2 power is cheaper than diesel.

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IMPACT & KEY CHALLENGES

Impact Analysis

(As of 2035)

Energy Security

1.1M GJ

= Energy consumption replaced by H_2 2.28M [GJ]* × Import ratio of pre-substitution energy sources 46[%]

Carbon Neutral

130Kt-CO_2

= Conventional fuel replaced by H_2 50k[t]** ×CO_2 emissions of conventional fuel 2.6[t-CO_2/t/t]

Economic Impact

470M USD/year

= Production Infrastructure 12M [USD]
+ Supply Infrastructure 7M [USD]
+ Utilization Infrastructure 450M [USD]

Key Challenges and Requirements

	Production	Transport	Storage	Use
Technology	**Technologies for large-scale production and cost reduction are still under development.**	Although key technologies have been developed, low-cost and easily deployable technologies are still under development. • Tank trucks • LH_2 tankers	Compressors have high manufacturing costs as well as high operating costs such as electricity consumption and maintenance.	**H_2 fuel cell generator : Insufficient durability, performance and high cost of components** • Performance improvement towards commercialization is required through demonstration. **Small H_2-diesel co-firing and mono-firing : Backfire and knocking, NOx emissions** • Further improvement through demonstration is needed to solve these problems.
Infra-structure	**H_2 production plants are insufficiently deployed in transport-accessible areas from remote diesel-dependent areas.**	**The deployment of tank trucks, medium-range pipelines and vessels for efficient H_2 supply is currently limited in remote diesel-dependent areas.** • Due to the lack of infrastructure, H_2 price tend to be expensive in remote diesel-dependent areas.		**The connection of HFCG to island and remote area grids, as well as continuous power generation and utilization, is still at an early stage (Gili Ketapang).** **Full diesel phase-out has not yet been achieved.**
Safety and Standards	**N/A** ISO standards on H_2 handling have already been localized. (ISO 15916)			**Domestic laws and guidelines regarding stationary fuel cell systems remain undeveloped.** • It is necessary to localize international standards (IEC).
	← **Comprehensive regulations for H_2 and NH_3 are required.** →			
Economic Incentive	← **Financial support throughout the supply chain from production to use yet to be developed.** • In 2035, the price gap between H_2 and diesel as fuels will be zero. • Since FC generators and compressors are expensive, CAPEX support will be required for their deployment. →			

* Energy consumption replaced by H_2 in this concept=H_2 demand for De-dieselization by Hydrogen 15,790 [t] based on RHAN × H_2 calorific value 144,527 [KJ/kg]
** Conventional fuel replaced by H_2= Energy consumption replaced by H_2 in this concept 2.28M [GJ] ÷ Calorific value conversion of conventional fuel 45,700 [KJ/kg]
Sources: The impact analysis is based on JICA's consultant team assumptions and calculations.

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TIMELINE

	2025–2030	2030–2035	2035–2040	2040–2045
	Initiation Phase		Development and Integration Phase	

Technology

Conversion Rate of Diesel Power Plants to H_2 Power Plants

2025–2030	2030–2035	2035–2040	2040–2045
~5%	~10%	~15%	~20%

Phased Deployment of HFCG in De-dieselization by Hydrogen

- Planning (Site, operation, project developers and target efficiency)
- Performance improvements such as the enhancement of stack durability, and the cost reduction of component and materials are achieved.
- HFCG deployment is being scaled up through off-grid connections and continuous operation.

Development of Small-scale H_2 Co-firing / Mono-firing Generator (2025–2035)

- The problems of backfire during combustion, NOx emissions, and knocking are resolved

Phased Deployment of Small- scale H_2 Mono-firing Generator (2035–2045)

- Planning (Site, operation, project developers, target efficiency)
- Deployment is being scaled up through the expansion of off-grid connections and constant operation.

Infrastructure

Development of infrastructure

- Production (Small scale H_2 production plants are constructed in nearby renewable-abundant areas.)
- Transport (H_2 transport by tank trucks・H_2 carriers ・Port side H_2 receiving infrastructure / Tank in remote area)

Safety and Standards

ISO standards on H_2 handling have already been localized.

Development of Safety Standards

- National regulations about FC aligned with the IEC tech standards are developed.

Development of Quality Standards

- H_2 Purity Requirements for FC is developed. Adoption of the ISO standards and localization of standards for Indonesia are achieved, aligning with existing national laws and regulations.

Operation and Revision of Standards

- Standards are reliably implemented under appropriate monitoring and are regularly revised based on operational feedback.

Economic Incentive

CAPEX Support (Infrastructure Subsidies, Concessional Finance)

Scheme (Share of Carriers in the Area, Effective H_2 Distribution Routes)

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COLLABORATION IDEA IN THE INITIATION PHASE (2025-2035)

Directions of Initiatives in the Initiation Phase to Achieve RHAN Targets

RHAN aims to replace diesel power generation in remote areas with hydrogen-based power generation.

- For remote diesel power plants, the target is to convert **5% of the total number of plants (2030), 10% (2035)** of electricity generation to hydrogen-based power.
- Currently, there are about **1,700 diesel power generation units** across Indonesia.

To achieve RHAN's goals, in the Initiation Phase, hydrogen-based diesel conversion must first be commercialized on several selected islands, and then commercialization must be achieved across the entire selected region.

- Specific regions will be selected, and pilot projects on several islands will be implemented to achieve early supply chain optimization and commercialization.
- Next, the model developed on the initial islands will be expanded across the region, completing full deployment by the end of the Initiation Phase and preparing for nationwide rollout in the Development and Integration Phase.

Hypotheses for Collaborative Initiatives in the Initiation Phase

	Commercialization in several islands	Commercialization in the entire selected region	Next Phases (2035~2060)
Outcome	**Establishment of an initial optimized supply chain model in several islands** • Achieving economic viability and establishment of commercialization models within individual supply chains of several islands	**Establishment of an optimized supply chain model throughout the entire selected region** • Achieving economic viability in a wide-area collaborative model for inter-island supply chains	**The model developed in the Initiation Phase will be replicated in other regions during the next phases.**
Project Image	**Project to transport off-site hydrogen as MCH to initial islands within the selected region and utilize it for FC power generation** • **East Java** is a promising region, as it includes many diesel-dependent islands. Particularly several islands are facing a shortage of reserve power, and are considered suitable as an initial model.	**Project to optimize inter-island ship transportation within the entire selected region** • In addition to expanding the initial transport-based model, an **inter-island network** will be developed by optimizing the hydrogen transportation network.	
Initiatives Jointly Implemented by Indonesia and Japan	**Design of individual supply chains** • Selection of areas, islands, production sites and carriers and economic design **Technology application** • HFCG, transport and storage facilities **Knowledge sharing for operation** • Practical guidelines	**Supply chain planning and infrastructure development** • Optimization of supply chains across the entire selected region – Optimized transport routes between islands • Design of support measures required for infrastructure deployment	

STRATEGIC COLLABORATION AREA

LAND TRANSPORT

KEMENTERIAN ESDM · JICA

CONCEPT PAPER

Background and Issues

Petroleum-based vehicles exacerbate CO_2 emissions and undermine energy security through rising fuel import dependency.

- Petroleum-derived fuels depend on imports about 40% or more of the total.
- Transport (automobiles and railroads) accounts for about 20% of CO_2 emissions in Indonesia.
- EVs contribute to carbon neutrality and energy security, but their long charging times and limited driving range make them unsuitable for long-distance transport and logistics.
- The Paris Agreement requires all participating countries to set Nationally Determined Contributions (NDCs), and the transport sector is one of the major sources of CO_2 emissions.
- Petroleum-based vehicles emit air pollutants (NOx, SOx, CO_2) during use.

Potential of H_2 and NH_3

H_2-powered vehicles are ideal for trunk-line logistics, as they enable the use of abundant renewable energy while supporting energy security, cleaner air, and carbon neutrality.

- FC trucks can be refueled in 15-20 minutes, can carry the same load as standard diesel trucks without heavy batteries, and can run up to 1,000 km on a single fill.
- Both clean H_2 and H_2-powered vehicles are expected to become cheaper.

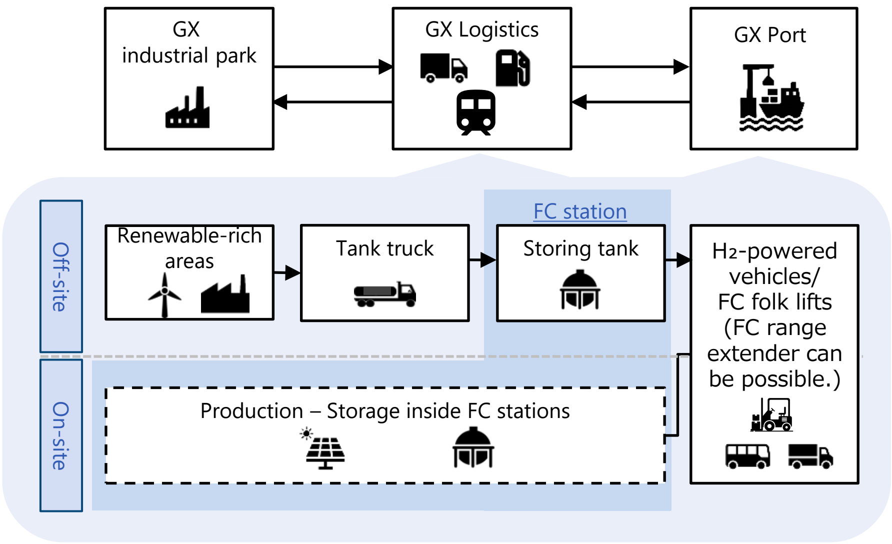
Concept

Overview

Shift from petroleum-based vehicles to H_2-powered vehicles

- Convert abundant renewable energy sources into H_2
- Promote the development of both H_2 fuel production and H_2 supply infrastructure
- H_2 is used both in logistics for H_2-powered vehicles and in ports for FC forklifts.

Image



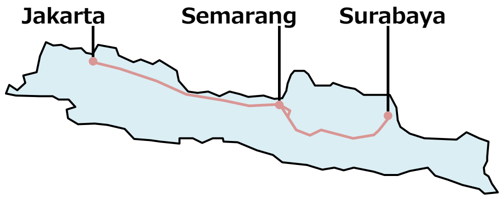
Facility

- H_2-powered vehicles/FC forklifts
- H_2 stations
- H_2 storage tanks
- H_2 transport vessels and tanks
- Port facilities
- (H_2 production plants and storage tanks)

Potential Place

Major intercity highways

- Trans-Java Toll Road
  - Connecting the major cities (1,167km)
- 61.6% of Indonesia's toll roads are concentrated on Java island*



Benchmarks

Patimban

Source : METI "Overview of MOU projects for the 2nd AZEC Ministerial Meeting (in Japanese)"

Promote GX of industrial park, logistics and ports thorough the supply of clean energy including clean H_2 and NH_3 (GX Corridor)

- Toyota Tsusho and Pertamina (H_2, NH_3)
- Demonstration in 2026.

Karawang

Source : MEMR presentation

H_2 refueling station in factory

- Toyota collaborated with Pertamina
- H_2 ecosystem inside the plant to support H_2-powered vehicles and forklifts

* JICA consultant team's analysis based on PwC Indonesia Trans-Java toll road saves time and Eduvest CAPACITY INCREASE PLAN ANALYSIS BY ADDING LANE TO THE JAKARTA-CIKAMPEK TOLL ROAD

Sources : Economic Research Institute for ASEAN and East Asia, Cost–Benefit Analysis on Oil Stockpiling in Indonesia, the Philippines, and Viet Nam, Teuku Naraski Zahari, Sustainability of Indonesia's transportation sector energy and resources demand under the low carbon transition strategies, METI https://www.meti.go.jp/policy/energy_environment/global_warming/azec/2nd_ministerial_meeting/2nd_AZEC_mm_mou_abstract_jp.pdf in Japanese, ANTARA JABAR, Business Design Of Public Electric Vehicle Charging Stations For Trans Java Cikampek – Surabaya Toll With The Dynamic System Approach

IMPACT & KEY CHALLENGES

Impact Analysis

As of 2035

Energy Security

0.20M GJ

= Energy consumption replaced by H_2*
0.43M [GJ]
× Import ratio of
pre-substitution energy sources 46[%]

Carbon Neutral

24K t-CO_2

= Conventional fuel replaced by H_2**
9.4k [t] ×
CO_2 emissions of
conventional fuel 2.6 [t-CO_2/t]

Economic Impact

320M USD/year

= Production Infrastructure 2.2M [USD]
+Supply Infrastructure 1.3M [USD]
+Utilization Infrastructure 312M [USD]

Key Challenges and Requirements

	Production	Transport	Storage	Use
Technology	**Technologies for large-scale production and cost reduction are still under development.**	Although key technologies have been developed, low-cost and easily deployable technologies are still under development. • Large-scale pipeline • Liquid H_2 tank truck	Regarding H_2 stations (H_2 compressors and H_2 dispensers), **high manufacturing costs, energy consumption, and maintenance** costs make monetization difficult.	**Lightweight high-pressure tanks cost as much as** USD 13,000 per unit. • H_2 fuel engines remain in demonstration due to challenges in H_2-air combustion. Fuel cells rely on **platinum, which is inherently expensive and scarce.** • Alternative catalysts to platinum are still under development.
Infrastructure	**H_2 production plants** are not located near land trunk road.	**H_2 pipelines** are still under construction, and **H_2 transport trucks** have not yet been widely deployed.	**Deployment of H_2 stations remains limited** to a few urban locations and is insufficient to support major land trunk roads.	Although the elemental technologies have been developed, the **deployment of fuel cell** trucks remains insufficient.
Safety& Standards	**N/A** ISO standards on H_2 quality and H_2 refueling station have already been localized. (ISO 14687 : H_2 quality, 19880 : H_2 refueling station)			**Rule amendments for H_2-powered vehicles are still pending.** • Relaxation of dimensional restrictions has not yet been implemented.
	← **Comprehensive regulations for H_2 and NH_3 are required.** →			
Economic Incentive	← **CAPEX support for infrastructure** has not yet been established. (Subsidies, Concessional Finance) →			**Demand stimulation measures** • Subsidies for purchase of **H_2-powered vehicles**, tax exemptions, traffic regulations, public procurement, mandatory implementation etc.
		← **Support measures have not yet been established to improve utilization rates.** (Optimal siting of H_2 stations through regional coordination / designation of priority areas and routes) →		
	← **Financial support and cost compensation mechanisms throughout supply chain have not yet been established.** • The price gap between H_2 (4.1 USD/kg) and diesel (3.6 USD/1kg-H_2) will be 0.5 USD/kg in 2035 →			

* Energy consumption replaced by H_2= H_2 demand for land transport 2,961 [t] based on RHAN × H_2 calorific value 144,527 [KJ/kg]
** Conventional fuel replaced by H_2= Energy consumption replaced by H_2 0.43M [GJ] ÷ Calorific value conversion of conventional fuel 45,700 [KJ/kg]
Sources: The price gap and impact analysis are based on JICA consultant team's assumptions and calculations.

TIMELINE

	2025–2030	2030–2035	2035–2040	2040–2045
	Initiation Phase		Development and Integration Phase	
Technology – Storage and Transport	H_2 pipelines, tankers and carrier trucks : Cost reduction, simplification of manufacturing and construction			
	H_2 stations (H_2 compressors and dispensers) : Improvement of manufacturing costs, maintenance costs and energy consumption			
Technology – Use	**H_2-powered vehicles** : Development of low-cost catalysts as alternatives to platinum and H_2-air combustion technology, cost reduction of light weight high-pressure tanks			
Infrastructure – Production	Construction of H_2 plants in renewable-abundant areas and near land trunk roads		Scale-up of H_2 plants in renewable-abundant areas and near land trunk roads	
Infrastructure – Storage and Transport	Construction of dedicated H_2 pipelines		Expansion of H_2 supply by dedicated H_2 pipelines	
	Deployment of demonstration facilities for high-pressure liquid H_2 storage and land transport		Scale-up of high-pressure liquid H_2 transportation by H_2 carrier trucks	
	Deployment of demonstration sites for H_2 stations	Deployment of H_2 stations along urban trunk road	Deployment of H_2 stations along regional trunk road	Nationwide deployment of H_2 stations
Infrastructure – Use	**Number of FCVs : 3,000 units**	**Number of FCVs : 20,280 units**	**Number of FCVs : 115,128 units**	**Number of FCVs : 184,929 units**
	Deployment of **H_2-powered vehicles** along land trunk			Nation wide deployment
Safety & Standards	**N/A** ISO standards on H_2 quality and H_2 refueling station have already been localized.	Operation and Revision of Standards: Standards are reliably implemented under appropriate monitoring and are regularly revised based on operational feedback.		
Economic Incentive	CAPEX Support : e.g., Subsidies* and Concessional Finance for H_2-powered Vehicles Purchases and H_2 Station Construction			
	OPEX Support : e.g., Support Measures through Supply Chain, Operational Subsidies for H_2 and H_2-powered Vehicles Related Companies			
	Scheme : Tax exemptions, traffic regulations, public procurement, mandatory implementation etc.			

* CAPEX support for BEVs can be used for FCVs.

Sources : RHAN (for figures), JICA consultant team's interview and analysis

COLLABORATION IDEA IN THE INITIATION PHASE (2025-2035)

Directions of Initiatives in the Initiation Phase to Achieve RHAN Targets

RHAN has set targets aiming for early commercialization and large-scale future adoption.

- Targets for FCV deployment : **3,000 units (2030), 20,280 units (2035), 3,633,120 units (2060).**

To achieve this target, in the Initiation Phase, commercialization of HRS and FCV must be realized at several locations.

- The rollout of HRS and FCVs should begin from designated parts of the main corridors. By the end of the Initiation Phase, they should be deployed across the selected regions.
  - Compared with urban road networks, main corridors are expected to require fewer HRS as an infrastructure.
- The deployment is the basis of nationwide application of HRS and FCVs.

Hypotheses for Collaborative Initiatives in the Initiation Phase

	Commercialization of FCVs and HRS in special zones	Commercialization of FCVs and HRS across the selected region	Next Phases
Outcome	**Concentrated rollout and commercialization of HRS and FCVs in special zones along main corridors.** • Focus on commercial and public vehicles	**Optimization and commercialization of HRS networks across the selected regions and progress in FCV deployment** • Expansion of target users to private passenger vehicles	**Based on the HRS network established in the Initiation Phase, it will be promoted the nationwide introduction of HRSs and FCVs in the next phases.**
Project Image	**Project to install sufficient HRS and prioritize the introduction of FCVs on promising trunk-corridor segments.** • **The special zones of the main corridors** should be chosen, considering hydrogen production and demand sites.	**Project to develop a network of HRS across the entire island of Java.** • HRSs within Java should be developed as an optimized supply network, promoting the utilization of FCVs throughout the island.	
Initiatives Jointly Implemented by Indonesia and Japan	**Establishment of an optimized supply chain within special zones** • Designate special zones and establish regulatory frameworks within them • Knowledge sharing related to technology and operations • Technology application • Provide support for the introduction FCVs as commercial and public vehicles	**Design and develop the HRS network in the selected region** • Establishment of incentive schemes for FCV adoption by both businesses and the private use • Knowledge sharing for HRS network optimization – Optimized deployment of HRS and route	

Sources : RHAN (for figures), JICA consultant team's interview and analysis

STRATEGIC COLLABORATION AREA

MARITIME TRANSPORT

CONCEPT PAPER

Background and Issues

Large ships mainly rely on imported fuel, which results in high CO_2 emissions. However, finding alternative fuels remains a major challenge.

- About 40% or more of the total petroleum-derived fuel is imported.
- The combined GHG emissions from Indonesia's maritime exports and imports account for 3.6% of total global international shipping emissions.
- Storage batteries are not suitable for large-scale maritime transport and biofuel production is inconsistent.
- It is difficult to meet the IMO's GHG reduction targets with current petroleum fuels.

Potential of H_2 and NH_3

Converting abundant domestic renewable energy resources into H_2 and NH_3 for marine fuels contributes to both energy security and decarbonization

- H_2 and NH_3 serve as both fuels and energy storage carriers.
- H_2 and NH_3 don't emit CO_2 during use
- It is necessary to examine comparisons, allocations, and combinations with other methods such as LNG and bio-fuel, as well as Indonesia's competitiveness as a supply hub for H_2 and NH_3.

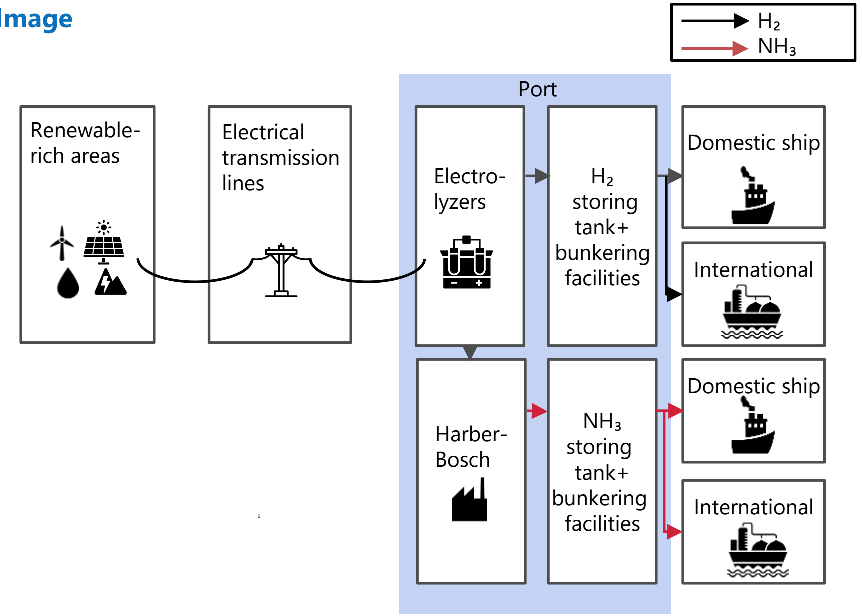
Concept

Overview

Replacing petroleum-based marine fuels with H_2 and NH_3 fuels

- H_2 and NH_3 production sites are possible both in renewable rich areas and in ports.
- Both patterns are conceivable : establishing H_2 and NH_3 production sites near ports or exporting H_2 and NH_3 fuels.

Image



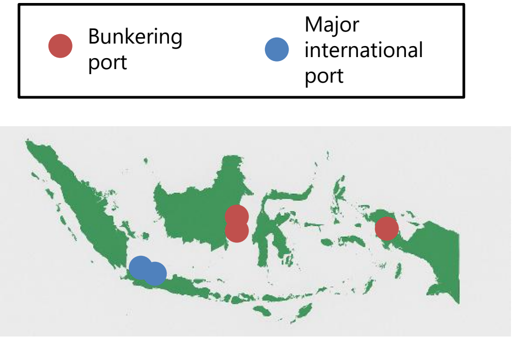
Facility

- H_2/NH_3-Fueled Ships
- H_2/NH_3 production plants
- H_2/NH_3 storing tanks
- H_2/NH_3 bunkering facilities
- Electrical transmission lines

Potential Place

Potential ports are chosen based on destinations and H_2/NH_3 production sites.

Potential Place Map



Especially, major international ports and bunkering ports have high potential.

- Tangguh port
- Bontang port
- Mahakam Delta port etc.

Benchmark

Aceh

Source : PT Pupuk Iskandar Muda HP

Produce clean NH_3 for ships using renewable-powered electrolyzers and existing Pupuk's plant (Project GAIA)

- ITOCHU and TOYO Engineering
- First commercial-scale clean NH_3 for marine fuel in Indonesia and globally

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IMPACT & KEY CHALLENGES

Impact Analysis

As of 2035

Energy Security

0.05M GJ

= Energy consumption replaced by H_2*
0.11M [GJ]
× Import ratio of
pre-substitution energy sources 46[%]

Carbon Neutral

6.7K $t\text{-}CO_2$

= Conventional fuel replaced by H_2 for H_2-based power generation 2.2K [t]** ×
CO_2 emissions of
conventional fuel 3.0 [$t\text{-}CO_2/t$]

Economic Impact

1.5M USD/year

= Production Infrastructure 0.5M [USD]
+Supply Infrastructure 0.4M [USD]
+Utilization Infrastructure 0.6M [USD]

Key Challenges and Requirements

	Production	Transport & Storage	Supply : Bunkering	Use
Technology	**Technologies for large-scale production and cost reduction are still under development.**	**H_2 : Structural optimization for liquid H_2 tanks on ships is still in progress.** • Achieve both low-temperature operation and high volumetric efficiency in liquefied H_2 tankers. • The current mainstream, high-pressure H_2 gas, has low transport efficiency. **NH_3 : NH_3 carriers require a leak prevention system.**	**H_2 : Offshore H_2 stations** (for medium to large vessels) are in the demonstration phase. **NH_3 :** There is **a leakage risk due to the high toxicity of NH_3.**	H_2 : Efficient combustion technology with sufficient vibration resistance for marine use has not yet been developed. **H_2-fueled ships have low co-firing ratios.** **NH_3 : NH_3-fueled ships have low co-firing ratios.**
Infrastructure	There are not enough **commercial-scale H_2 plants** near ports or renewable-abundant areas.	Transport infrastructure between H_2 production sites and ports such as **tank trucks and pipelines** is insufficient. **Large-scale H_2/NH_3 storage tanks** are still under development.	**Bunkering facilities, H_2 stations, and pipelines** at ports remain underdeveloped.	The demonstration and deployment of **NH_3/H_2-fueled ships** are still limited.
Safety& Standards	**N/A** ISO standards on H_2 quality have already been localized. (ISO 14687)	← **Standards aligned with IMO and international mutual recognition standards** have not yet been established. • Interoperability across the entire supply chain is still under development. →		**Regulations aligned with IMO maritime transport standards** have not yet been developed. • Construction standards for hazardous cargo ships and operation rules
Economic Incentive	← **It is necessary to implement cost reduction measures through shared infrastructure.** → **Further establishment of financial support throughout the supply chain, from production to use, is required.** • The price gap between H_2 (4.1 USD/kg) and VLSDO (1.7 USD/1kg-H_2) will be 2.4 USD/kg in H_2-fueled ships. • The price gap between NH_3 (3.7 USD/1kg-H_2) and VLSDO (1.7 USD/1kg-H_2) will be 1.9 USD/kg in NH_3-fueled ships.			**Preferential schemes for clean fuels, compared to fossil fuels, are needed.** • Blending mandates and redistribution mechanisms under the IMO.

* Energy consumption replaced by H_2= H_2 demand 726[t] based on RHAN × H_2 calorific value 144,527 [KJ/kg]
** Conventional fuel replaced by H_2= Energy consumption replaced by H_2 0.11M [GJ] ÷ Calorific value conversion of conventional fuel 47,311[KJ/kg]
Sources The price gap and impact analysis are based on JICA consultant team's assumptions and calculations.

KEMENTERIAN ESDM JICA

TIMELINE

2025–2035: Initiation Phase		2035–2045: Development and Integration Phase	
2025	2030	2035	2040

Technology

Transport and Storage

Initiation Phase (2025–2035)	Development and Integration Phase (2035–2045)
Structural optimization for H_2 tanks on ships and improvement of H_2 storage efficiency	Cost reduction of facilities is achieved. Infrastructure and ships are scaled up, and their operations are optimized.
Enhancement of leak prevention systems considering NH_3 toxicity	

Use

2025–2030	2030–2035	2035–2040	2040–2045
H_2 demand for ships : N/A	**H_2 demand for ships : ~726 t**	**H_2 demand for ships : ~14,218 t**	**H_2 demand for ships : ~46,035 t**
Development of NH_3-fueled ships	Initiation of stakeholder collaboration of NH_3	Increase in NH_3 co-firing ratio	Reduction of NH_3/NH_3-fueled ships
Development of H_2-fueled ships (Efficient combustion technology with vibration resistance)		Utilization of H_2-fueled ships	Development and utilization of FC ships

Infrastructure

Production

Initiation Phase (2025–2035)	Development and Integration Phase (2035–2045)
Construction of H_2 plants in renewable-abundant areas and near ports	Scale-up of H_2 plants in renewable abundant areas and near ports

Transport, Storage and Bunkering

Initiation Phase (2025–2035)	Development and Integration Phase (2035–2045)
Deployment of H_2 tank trucks, tank ships, pipelines and storage tanks	Expansion of H_2 tank trucks, tank ships pipelines, and storage tank networks
H_2 : Deployment of cartridge type bunkering facilities (Transitional use until the scale-up of onshore fixed stations and offshore stations)	H_2: Scale-up of bunkering facilities (Onshore fixed stations and offshore stations)
H_2 : Development of bunkering facilities (Onshore fixed stations and offshore stations)	
NH_3 : Development of bunkering facilities (Offshore stations and bunkering ships)	NH_3 : Deployment of large-scale commercial offshore stations and bunkering

Safety & Standards

Development of Standards	Operation and Revision of Standards
Safety : Localization of the IMO and other international standards for maritime transport and port facilities	Operation based on bilateral and multilateral mutual recognition of safety/fuel standards
Quality : Establishment of H_2/NH_3 purity standards by ship engine manufacturers	Standards are reliably implemented under appropriate monitoring and are regularly revised based on operational feedback.

Economic Incentive

CAPEX Support : e.g., Subsidies and Concessional Finance for H_2 Plant and H_2/NH_3-Fueled Ships Manufacturing Facilities and Purchase of These Ships

OPEX Support : e.g., Support Measures through Supply Chain and Manufacturing Cost Support for H_2 and H_2/NH_3-Fueled Ships

Scheme : e.g., Cost Reduction through Shared Infrastructure, Diversification of Supply Destinations, and IMO-mandated Blending Obligations

Sources : RHAN (for figures), JICA consultant team's interview and analysis

COLLABORATION IDEA IN THE INITIATION PHASE (2025-2035)

Directions of Initiatives in the Initiation Phase to Achieve RHAN Targets

RHAN aims for large-scale future use of hydrogen/ammonia-powered ships

- By 2035, the total loading capacity of hydrogen-fueled ships will reach 53 million DWT.
- Based on hydrogen demand from ships, the demand will reach 726 tons by 2035.

To achieve RHAN's goals, in the Initiation Phase, port infrastructure should be prepared at a selected port, and demonstrations of hydrogen/ammonia-fueled ships should be conducted.

- Through feasibility studies, the safety and operational stability of ammonia/hydrogen co-firing and GHG emissions should be verified.
- The technology and infrastructure established here will serve as the foundation for expansion in the next phases.

Hypotheses for Collaborative Initiatives in the Initiation Phase

	Supply	Use
Outcome	**Value chain design to supply hydrogen / ammonia by ship-to-ship bunkering** • Verifying feasibility and cost effectiveness of ship-to-ship bunkering	**Demonstration of hydrogen/ammonia co-firing ships' safe, stable, and low-emission operation** • Engine performance and post-operation component inspection
Project Image	**Project to design and demonstrate ship-to-ship bunkering** • Developing minimum port infrastructure to realize ship-to-ship bunkering • Conducting a trial with multi-stakeholders to identify bottlenecks and further requirements	**Project to introduce hydrogen/ammonia ships on short domestic routes** • Continuous trials are conducted over a certain period to verify the fuel supply system and operational functions in a short distance domestic route with a view to future international transportation.

Initiatives Jointly Implemented by Indonesia and Japan

Design of supply chain

- Supply chain design that is suitable for initial societal implementation while also considering future scalability

Technology application

- Hydrogen/ammonia co-firing engines, measurement equipment, transport and storage infrastructure

Knowledge sharing

- Operational guidelines for hydrogen/ammonia-fueled ships, referencing IMO
- Guidelines for port operations

Next Phases

H_2 and NH_3 infrastructure expands, utilization of H_2/NH_3-fueled ships accelerates, and their economic viability is realized.

Sources : RHAN (for figures), JICA consultant team's interview and analysis

STRATEGIC COLLABORATION AREA

OVERSEAS EXPORTS

CONCEPT PAPER

Background and Issues

Indonesia's reliance on natural resources such as coal for its exports makes it vulnerable to international energy policies and price fluctuations.

- With 50.3% of exports being resource-based, there is a clear need for a shift towards higher value-added industries.
- Regulations and standards for hydrogen export have yet to be fully established.
- As the world's top coal exporter (534 Mt), Indonesia faces risks from import restrictions and its reliance on China and India (62.7%).

Potential of H_2 and NH_3

Medium-to long-term efforts to secure clean H_2/NH_3 are underway in Japan, South Korea, Europe and Singapore, among other countries.

They need imported H_2/NH_3 from countries with abundant renewable energy resources.

- It is necessary to examine Indonesia's competitiveness in hydrogen exports, particularly in terms of price and location.
- Abundant renewable energy resources, existing export ports, and H_2/NH_3 production facilities are utilized to build a clean H_2/NH_3 supply chain.
- There is high demand for clean hydrogen in Japan and Singapore, which will contribute to the diversification of export destinations.

Concept

Overview

Export clean H_2 and NH_3 produced by renewable energy to high demand countries

- To Singapore via pipeline
- To distant demand countries (Japan, South Korea) by ship
- Achieve export diversification, higher value-added exports, reduced resource dependence, and increased foreign currency earnings through clean H_2 and NH_3 exports

Image

Port
H_2 /NH_3 storage tanks

→ **Various pipeline transport methods**
- High-pressure H_2 gas etc.

→ **Various ship transport methods**
- Liquid H_2
- MCH
- H_2 storage alloy
- NH_3
- e-methane etc.

→ Export destination
- Singapore
- Japan
- Korea
- EU
- Others

Facility

- Export pipelines for H_2/NH_3
- Port export facilities for H_2 / NH_3
- H_2/NH_3 transport ships
- H_2/NH_3 production plants
- H_2/NH_3 storage tanks
- Electrical transmission lines

Potential Place

Potential export ports are chosen based on destinations and H_2/NH_3 production sites.

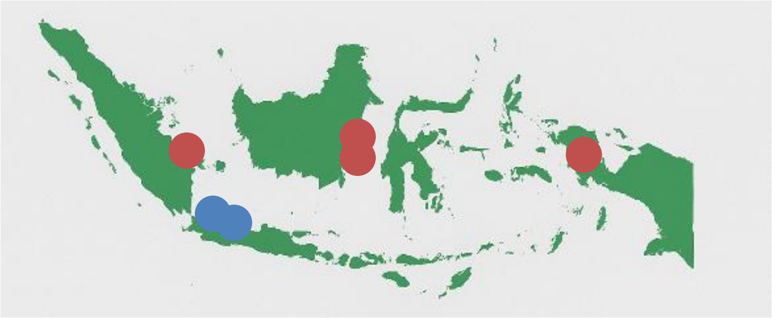
Especially, major international ports and bunkering ports have high potential as H_2/NH_3 export ports.

- Tangguh port
- Bontang port
- Mahakam Delta port, etc.

As for pipelines, existing international pipelines can be utilized after an adequate retrofit.

Potential Place Map

Bunkering port/ pipeline | Major international port



KEMENTERIAN ESDM · JICA

IMPACT & KEY CHALLENGES

Impact Analysis

As of 2035

Energy Security

N/A

= Energy consumption replaced by H_2* 33M [GJ]
× Import ratio of pre-substitution energy sources 0[%]

Carbon Neutral

N/A

= Conventional fuel replaced by H_2 for H_2-based power generation N/A[t]** × CO_2 emissions of conventional fuel N/A [t-CO_2/t]

Economic Impact

550M USD/year

= Production Infrastructure 170M [USD]
+Supply Infrastructure 110M [USD]
+Utilization Infrastructure 0M [USD]
+Export impact 270M[USD]

Key Challenges and Requirements

	Production	Storage	Transport	Use
Technology	**Technologies for large-scale production and cost reduction are still under development.**	High-pressure H_2 gas is currently mainstream but has **low transport efficiency.** Liquid H_2 requires **high energy for cooling.** MCH requires **high-temperature heat**, and **integration of technologies** has not yet been achieved. H_2 storage alloys have **low weight-based efficiency.** NH_3 handling is restricted due to its **toxicity.**	**There is currently limited retrofit technology available for H_2 pipelines, such as leak detection and embrittlement prevention.** **Liquid H_2 ships must maintain it at a constant low temperature.** **NH_3,MCH and H_2 storage alloys can be used in existing ships.**	Depends on use case
Infrastructure	**Commercial-scale H_2 plants near renewable-abundant area/ports have not yet been deployed.**	**H_2 export hub ports have not yet been designated.** **Necessary infrastructure is still under development.** • H_2 storage tanks	**Bilateral H_2/NH_3 shipping is still in demonstration; long-term commercial export has not yet been realized.** **Cross-border H_2/NH_3 pipeline infrastructure is still under development.**	
Safety& Standards	There is a need for **an MRV system aligned with importer's low-carbon H_2 standards.**	**Regulations aligned with international safety standards have not yet been established.** • Pipelines, tanks with explosion-proof and toxic substance regulations **IMO standards for maritime transport have not yet been established.** • Shipbuilding standards for hazardous cargo, maritime transport regulations **Bilateral regulatory harmonization** is still under development (supply chain compatibility).		
Economic Incentive	**Structured preferential treatment for clean H_2 compared to grey H_2 through partnerships** has not yet been established. • Price gap support from the importing country, tariff reductions, investment/financing based on off-take agreements **Differentiation from H_2-exporting competitor countries** has not yet been achieved. • Provision of export credit, improvement of the investment/financing environment **Financial support throughout the supply chain from production to use** has not yet been established. • The price gap between clean H_2 (5.2 USD/kg) *** and H_2 import goals of Japanese government (2.2USD/kg) will be 3.0 USD/kg.			

* Energy consumption replaced by H_2= H_2 demand 226,761[t] based on RHAN × H calorific value 144,527[KJ/kg], H_2 demand is calculated as the sum of electrolysis hydrogen production and CCS hydrogen production in RHAN, minus the total hydrogen demand in RHAN.
** Conventional fuel replaced by H_2= Energy consumption replaced by H_2 32.77M[GJ] ÷ Calorific value conversion of conventional fuel N/A[KJ/kg]
*** Green H_2 price = H_2 production price + H_2 transportation costs
Sources The price gap and impact analysis are based on JICA consultant team's assumptions and calculations.

KEMENTERIAN ESDM | JICA

TIMELINE

	2025–2035: Initiation Phase		2035–2045: Development and Integration Phase	
Technology				
Production	Clean H_2 production* : ~377,198 t	Clean H_2 production : ~1,453,372 t	Clean H_2 production : ~2,885,037 t	Clean H_2 production : ~5,070,580t
Transport and Storage	High-pressure H_2 : Improved transport efficiency and short-distance delivery			Scale up and cost reduction of H_2 transport ships (Liquid H_2/MCH/H_2 storage alloy)
	Technology development of H_2 carriers Liquid H_2 : Efficiency improvement in cooling energy consumption, MCH : Enhanced energy efficiency (High-temperature is required) H_2 storage alloy : Improved transport efficiency per weight			
	Technology development of NH_3 carriers (Addressing toxicity and odor)	Scale-up and cost reduction of NH_3 transport ships		
	Pilot demonstration of H_2 pipeline between Indonesia and Singapore	Scale-up and cost reduction of H_2 pipeline between Indonesia and Singapore (Establishment of retrofit technologies: Leak detection, embrittlement)		
Infrastructure				
Production	Construction of H_2 plants in renewable-abundant areas and near export ports		Scale-up of H_2 plants in renewable abundant areas and near export ports	
Transport and Storage	Deployment of H_2 export facilities at ports (H_2 transport ships, tanks, bunkering facilities, pipelines)		Scale-up of H_2 export facilities at ports (H_2 transport ships, tanks, bunkering facilities, pipelines)	
Safety & Standards	**Development of Standards**		**Operation and Revision of Standards**	
	Safety: Standardization of ports and pipelines in line with international rules Standardization of H_2/NH_3 carrier ships in line with IMO		Cross-border mutual recognition and harmonization have been established. Standards and systems are reliably implemented under appropriate monitoring and are regularly revised based on operational feedback.	
	Quality : Mutual recognition of low-carbon hydrogen requirements and certifications Development of an MRV system			
Economic Incentive	CAPEX Support : e.g., Subsidies and Concessional Finance for H_2 Plant and H_2/NH_3 Fueled Ships Manufacturing Facilities and Purchase of These Ships			
	OPEX Support : e.g., Support Measures through Supply Chain, Tariff Reduction, Differentiation from Other Export Countries, Export Credit			
	Scheme : e.g., Improvement of Investment Environment thorough Collaboration with Importing Countries			

* The sum of RHAN's clean hydrogen production targets for technologies with proven maturity, specifically electrolysis and CCS.

Sources : RHAN (for figures), JICA consultant team's interview and analysis

KEMENTERIAN ESDM

COLLABORATION IDEA IN THE INITIATION PHASE (2025-2035)

Directions of Initiatives in the Initiation Phase

※In RHAN, there is no numeric targets specifically for exportation

However, Indonesia has a decent potential with the targets in H_2 production and can benefit from exporting it with huge economic impact

- Indonesia has traditionally exported energy resources to adjacent countries such as Singapore, Korea, and Japan, which will gradually shift to carbon neutral resources including hydrogen and ammonia

To build large scale cross-boarder supply chain, initial design committed by both exporter and importer is indispensable

- In this early stage, design of domestic supply chain and demonstration of pipelining or maritime transport need to be conducted by Indonesia and demand-side countries' consortium
- In the later stages, more precise FEED is conducted to structure the entire supply chain and start trading under both countries' governmental supports

Hypotheses for Collaborative Initiatives in the Initiation Phase

Design and demonstration of entire supply chain in selected areas

Outcome

Identifying potential supply chain model and understand roles for both exporter and importer's sides

- Especially for export, which requires large scale supply chain, identifying suitable places and methodologies in entire activities
- Forging relationship between Indonesian potential exporters and demand countries' potential off-takers for future mass transaction

Project Image

Project to do feasibility study and demonstrate H_2 bilateral supply chain

- Between H_2 hub ports or clusters in Indonesia and demand-side countries, H_2 is shipped on maritime in demonstration level
  - E.g.,) Infrastructure (pipelining or maritime shipping), Carrier type, …
- Paving trading and infrastructure rules

Initiatives Jointly Implemented by Indonesia and Japan

Design of supply chain

- Forming alliances between Indonesia and demand-side countries' players for project plannings
- Economic calculation and feasibility study
  - Considering strategic variables such as carrier types, routing, etc.

Technology application

- Maritime transportation ship and carrier technologies

Knowledge sharing

- Operational guidelines for maritime shipping H2/NH3 and ports

Next Phases

Based on the result of shipping demonstration, precise FEED will be conducted.

In Development and Integration phase, H_2 trading with potential demand countries will be realized.

STRATEGIC COLLABORATION AREA

POWER GENERATION

CONCEPT PAPER

KEMENTERIAN ESDM | JICA

Background and Issues

Coal and gas currently dominate power generation, while renewables remain limited. Using coal results in the emission of high levels of GHG and air pollutants.

- The power sector accounts for 43% of total CO_2 emissions in Indonesia.
- Energy mix:Coal 61.9%, gas 17.4%, renewables 19.0%
- Air pollutant emissions from coal plants rose 110% over the past decade.
- On the other hand, there are places in regions rich in renewable energy where its potential is not being fully utilized.
  - In Sumatra, approximately 14% of solar PV generation is curtailed due to unstable supply, inflexible power purchase agreements, limited flexibility of other power plants, and inadequate transmission and storage infrastructure.

Potential of H_2 and NH_3

Converting surplus electricity from nearby renewable energy sources into H_2 / NH_3 for combustion-based power generation enables decarbonization.

- H_2 and NH_3 are clean energy carriers that emit neither CO_2 nor pollutants when used in combustion.
- Stable electricity supply can add more value than variable renewable energy like solar.

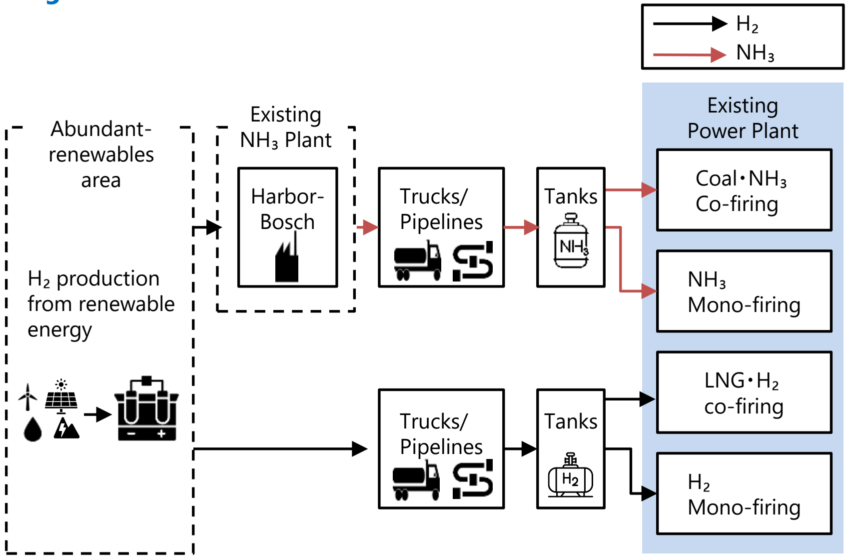
Concept

Overview

Replacing existing coal and gas-fired power generation with combustion of renewable-based H_2 / NH_3

- Initially, H_2 will be co-fired with LNG and NH_3 with coal, with the goal of eventually achieving 100% mono-firing of H_2 / NH_3

Image



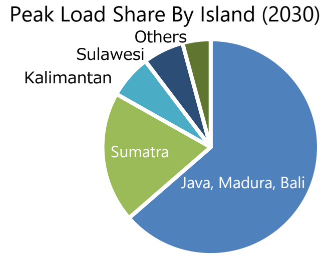
Facility

- H_2 / NH_3 production plants
- H_2 / NH_3 storage tanks
- Fuel supply and handling systems
- H_2 / NH_3-compatible power generation units
- Emission monitoring systems (Nox from NH_3 combustion)

Potential Place

Islands with high electricity demand and many thermal power plants have high potential.

- Java, Madura, Bali
- Sumatra



Benchmarks

Labuan

Source : MEMR presentation

Pilot test of clean NH_3 co-firing at commercial coal power plant

- Converted existing burner to IHI NH_3 burner with the cooperation of PLN and Pupuk
- Clean NH_3 is produced by Pupuk Kujang.

Muara Karang

Source : Mitsubishi Heavy Industries HP, "Commencement of operation of a 500,000 kW-class natural gas-fired GTCC power generation facility in Indonesia – Muara Karang Power Plant operated by state-owned PLN on the northwestern coast of Java (in Japanese)"

Co-firing H_2 and NH_3 at power plants

- At PLN power plants using equipment, turbines and boilers, supplied by Mitsubishi Heavy Industries
- Hydrogen co-firing with existing gas turbines, and NH_3 co-firing with gas-fired boilers

KEMENTERIAN ESDM

IMPACT & KEY CHALLENGES

Impact Analysis

〔 As of 2035 〕

Energy Security

N/A

= Energy consumption replaced by H_2*
11M [GJ]
× Import ratio of
pre-substitution energy sources 0[%]

Carbon Neutral

600K t-CO_2

= Conventional fuel replaced by H_2 for H_2-based power generation 170k[t]** ×
CO_2 emissions of
conventional fuel (gas) 2.7[t-CO_2/t]
+ Conventional fuel replaced 45k [t]by H_2 for NH_3-based power generation**× conventional fuel (coal) 3.2[t-CO_2/t]

Economic Impact

60M USD/year

= Production Infrastructure 55M [USD]
＋Supply Infrastructure 2M [USD]
＋Utilization Infrastructure 3M [USD]

Key Challenges and Requirements

	Production	Storage/Transport	Use
Technology	**Technologies for large-scale production and cost reduction are still under development.**	**Large-scale pipelines, tank trucks and high-pressure tanks are required, and the technology itself is already established. The CAPEX optimization is ongoing. In addition, the common use of shared infrastructure, such as receiving and storage terminals, is widespread across industrial sectors.**	**A gradual increase in the H_2/NH_3 co-firing ratio is required, but the following challenges remain.** • H_2 combustion (Backfire at higher H_2 blending, NOx formation, Equipment damage due to combustion oscillation) • NH_3 combustion (Unburned NH_3 formation, NOx formation)
Infrastructure	**Mass H_2/NH_3 production plants near power plants are still limited.**	In most probable locations, **storage tanks and delivery networks (pipelines and tank trucks)** between H_2 / NH_3 production sites and demonstration cities are still under development.	Although elemental technologies exist, **power generation systems capable of sustained commercial operation at medium to large scales (several hundred MW to 1GW) by firing H_2/NH_3** have yet to be developed.
Safety & Standards	**Manufactures have not yet established handling manuals or defined impurity tolerance levels.**	**The development of H_2 / NH_3 pipeline standards based on existing LNG pipeline standards is insufficient.** • Risk of embrittlement, leakage, safety distance	**Safety standards remain undeveloped.** • Risk assessments and operational guidelines specific to H_2/NH_3-fired power generation remain undeveloped
Economic Incentive			**Utilization of electricity market mechanisms** is insufficient.

← **Further establishment is needed in financial support and cost compensation mechanisms throughout the supply chain** →

- The price gap between H_2 (4.1 USD/kg) and LNG (1.2 USD/1kg-H_2) will be 2.9 USD/kg as of 2035 in H_2 power generation.***
- The price gap between H_2 (4.1 USD/kg) and coal (2.0 USD/1kg-H_2) will be 2.1 USD/kg as of 2035 in NH_3 power generation.

* Energy consumption replaced by H_2= (H_2 demand for H_2-based power generation 63,709 [t] based on RHAN+ H_2 demand for NH_3-based power generation 9190 [t] based on RHAN) × H_2 calorific value 144,527 [KJ/kg]
** Conventional fuel replaced by H_2= Energy consumption replaced by H_2 in each power generation [GJ] (H_2/NH_3)÷ Calorific value conversion of conventional fuel [KJ/kg] (gas/coal)
*** Price is shown per energy equivalent of 1 kg-H_2 (not per kg-NH_3), for easier comparison with hydrogen co-firing.
Source: The price gap and impact analysis are based on JICA consultant team's assumptions and calculations.

KEMENTERIAN ESDM

TIMELINE

	2025–2030	2030–2035	2035–2040	2040–2045
	Initiation Phase		Development and Integration Phase	
Technology	**H_2 Co-firing / Mono-firing**			
	Target Co-firing ratio 0~3%	Target Co-firing ratio 3~10%	Target Co-firing ratio 10~30%	Target Co-firing ratio 30~60%
	Pilot demonstration		Commercialization	
	Technology development (Backfire control and NOx emission control)		Performance improvement and scale-up (1GW and above)	
	NH_3 Co-firing / Mono-firing			
	Target Co-firing ratio 3~10%	Target Co-firing ratio 10~30%	Target Co-firing ratio 30~60%	Target Co-firing ratio 60~100%
	Pilot demonstration		Commercialization	
	Technology development (Unburned residue control・NOx emission control)		Performance improvement・Scale-up	
Infrastructure	**Production**			
	H_2 production facilities are built and operational in regions-abundant regions and near H_2/NH_3 power plants		Commercial-scale H_2 plants are in place at production bases, supplying demand in special zones and surrounding areas.	
	Storage and Transport			
	Establishment of a network connecting H_2 production plants in renewable-abundant areas and large-scale thermal power plants (pipelines and tank trucks)			
	Installation of power plant H_2 tanks and H_2 plant storage tanks			
Safety & Standards	**Development of Standards**		**Operation and Revision of Standards**	
	Safety: Risk assessments and operational guidelines		Standards are reliably implemented under appropriate monitoring and are regularly revised based on operational feedback.	
	Fuel quality: Impurity tolerance levels and corresponding manuals			
Economic Incentive	**CAPEX Support : e.g., Subsidies are in Place to Support the Construction of H_2/NH_3-fired Power Plants and Related Infrastructure Development**			
	OPEX Support : e.g., Support Measures through Supply Chain			
	Scheme : e.g., Government Support for Power Generation, Cost Compensation Mechanisms to End Users, Effective Electricity Market Mechanisms			

Sources : RHAN (for figures), JICA consultant team's interview and analysis

COLLABORATION IDEA IN THE INITIATION PHASE (2025-2035)

Directions of Initiatives in the Initiation Phase to Achieve RHAN Targets

RHAN expects the large-scale introduction of hydrogen and ammonia mono-firing power generation by 2060.

- Nationwide generation capacity
  - Hydrogen : **4GW (2050), 8.4GW (2060)**
  - Ammonia : **4GW (2050), 25.3 GW (2060)**
- Target co-firing ratio
  - Hydrogen : 3% (2030), 10% (2035)
  - Ammonia : 10% (2030), 30% (2035)
- Ammonia co-firing precedes hydrogen co-firing.

To achieve RHAN's targets, from the Initiation Phase, demonstration projects for hydrogen and ammonia co-firing must be conducted and gradually increase the co-firing ratio.

- Addressing co-firing challenges to improve co-firing ratios.
- Establishment of safe and stable operation technology in the Initiation Phase will lead to commercialization.

Hypotheses for Collaborative Initiatives in the Initiation Phase

Gradual Increase in the Co-firing Ratio (Hydrogen and Ammonia) → **Next Phases**

Outcome

Hydrogen and Ammonia co-firing ratio improvement

- Hydrogen: Establishment of mitigation measures for backfire, NOx formation, and equipment damage due to combustion oscillations
- Ammonia: Establishment of mitigation measures for unburned NH_3 (ammonia slip) and NOx formation

Project Image

Individual co-firing demonstration and study at existing plants

- Conducting individual co-firing demonstrations and research to achieve RHAN's target co-firing rates: for hydrogen co-firing at multiple gas power plants and for ammonia co-firing at multiple coal power plants

Integrated demonstration project from production to power utilization at a single site

- Facility at a single site housing hydrogen production equipment, hydrogen storage facilities, and hydrogen co-fired power generation equipment enables integrated demonstration for hydrogen's widespread adoption

Initiatives Jointly Implemented by Indonesia and Japan

Technical collaboration for individual demonstrations

- Technology application
- Knowledge sharing on operation, equipment, combustion methods, etc.
- Establishment of safety standards and guidelines for ammonia co-firing

Technical collaboration for integrated demonstrations

- Site selection, operator selection, and overall supply chain management for integrated demonstration sites

Next Phases

The co-firing ratio will continue to increase in the next phase.

Once mono-firing is successfully demonstrated at a few pilot plants, the model will be rolled out across Indonesia.

Sources : RHAN (for figures), JICA consultant team's interview and analysis

STRATEGIC COLLABORATION AREA

AVIATION

CONCEPT PAPER

Background and Issues

Aviation sector in Indonesia relies heavily on imported jet fuel, which has a detrimental effect on both CO_2 emissions and energy security.

- Indonesia consumes 3.5 million KL of aviation fuel per year and is dependent on imported petroleum-derived fuels, which account for 40% or more of the total.
  - Juanda Airport alone emitted 2.3 Mt CO_2 from domestic flights in 2018*.
- Although the achievement of ICAO's CAAF** (~'30, 5% CO_2 reduction) is important, it is difficult to achieve the goal with petroleum-based aviation fuels.

Potential of H_2 and NH_3

The production of SAF from domestic feedstocks helps to ensure energy security and does not result in the release of carbon dioxide during use.

- Indonesia offers abundant feedstocks for HEFA such as palm oil residues, off-spec coconuts and used cooking oil.
- Clean H_2 is required for SAF production by HEFA, ATJ and PTL methods, etc.
- Producing sufficient SAF domestically enables the achievement of ICAO targets.
- HEFA is a mature SAF production technology that requires a certain amount of H_2.

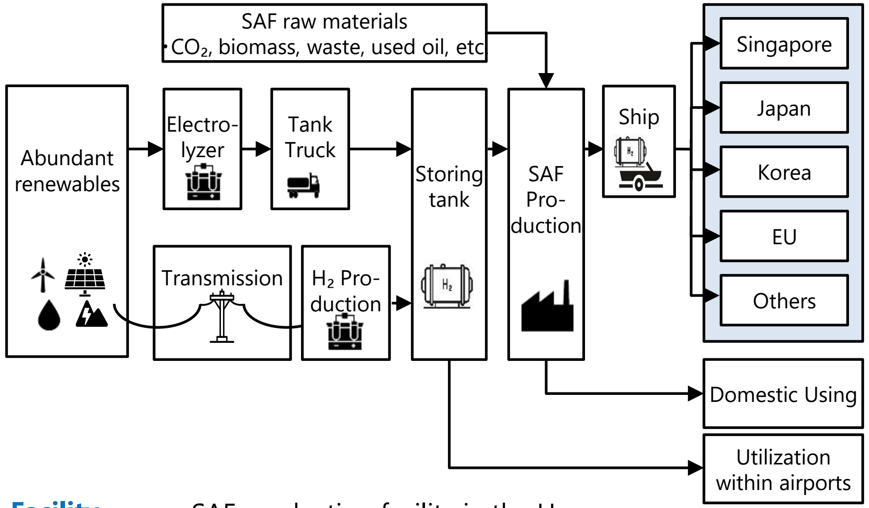
Concept

Overview

Transition from petroleum-based jet fuel to SAF using clean H_2

- Applicable for both domestic use and export
  - Global demand for CORSIA-compliant SAF is rising across many countries (e.g., EU, Singapore, Japan).
- H_2 is used in both production and as part of the final fuel.
- Moreover, H_2 can be used for mobility within airports.

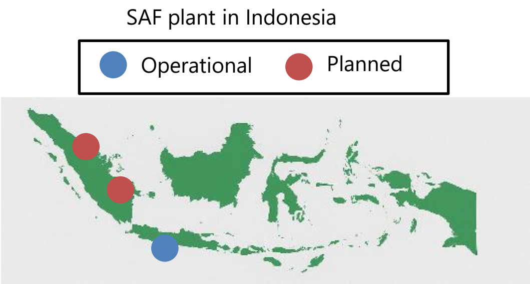
Image



Facility

- SAF production facility in the H_2
- Feedstock pretreatment plants
- SAF-compatible aircrafts
- SAF storage and export facilities
- (H_2 production plants and H_2 storage tanks)

Potential Place



Airport / Export point

Regions with abundant feedstocks

- Renewable energy, Biomass

Existing facilities (Fossil fuel refinery)

* The third busiest airport in Indonesia (by passenger traffic)

** Conference on Aviation and Alternative Fuels (CAAF/3)

Sources : ITS Analysis of Carbon Footprint in the Indonesian Aviation Industry, Case Study: Juanda International Airport,The Global Economy.com Indonesia: Jet fuel consumption, Economic Research Institute for ASEAN and East Asia, Cost–Benefit Analysis on Oil Stockpiling in Indonesia, the Philippines, and Viet Nam

IMPACT & KEY CHALLENGES

Impact Analysis

As of 2035, based on the **SAF Action Plan (2025-2029)***

Energy Security

6.7M GJ

= Energy consumption replaced by H_2** 15M [GJ]
× Import ratio of pre-substitution energy sources 46[%]

Carbon Neutral

800K t-CO_2

= Conventional fuel replaced by H_2** 320K [t] ×
CO_2 emissions of conventional fuel 2.5 [t-CO_2/t]

Economic Impact

160M USD/year

= Production Infrastructure 77M [USD]
+Supply Infrastructure 7M [USD]
+Export Impact 72M[USD]

Key Challenges and Requirements

	H_2 Production/ Transport	Procure SAF Materials	SAF Production	Transport	Use (SAF)
Technology	**Technologies for large-scale production and cost reduction are still under development.**	N/A	**All kinds of SAF technologies require cost reduction in production.** • AtJ is expensive due to the requirements for high-temperature and high-pressure.	N/A	**Aircraft compatible with 100% SAF are still under development.** • Up to 50% of the fuel can be mixed with existing fuel on existing aircraft.
Infrastructure	**H_2 production plants have not yet been sufficiently developed in areas rich in SAF feedstock.**	**SAF feedstock supply and production systems remain underdeveloped.** • Feedstock collection system • Storage facilities	**SAF production is still limited to demonstration-scale, with commercial-scale facilities being scarce.** • Even domestic demand is not sufficiently met, let alone exports.	N/A	
Safety& Standards	**N/A** ISO standards on H_2 quality have already been localized. (ISO 14687)	**Standards for feedstock that also take environmental protection into account have not yet been established.**	← **MRV systems for SAF based on CORSIA has not yet been developed.** • SAF quality and GHG emission pathway tracking covering the entire process from feedstock production to end use • Lifecycle GHG emissions are traceable. →		**Need for guidelines for SAF compatible aircraft**
Economic Incentive	← **Gaps in financial support and incentives throughout the supply chain** • The price gap between SAF (4.7 USD/1kg-H_2) and Jet fuel (2.8 USD/1kg-H_2) will be 1.9 USD/kg as of 2035. – SAF credit, SAF production or purchase subsidies, Green finance, SAF blending mandate based on CORSIA – R&D of 100% SAF-compatible aircraft →				

* Since RHAN lacks SAF projections for 2035, estimates based on Indonesia's ministry of investment's remark about SAF Action Plan(2025-2029) at Bali international Air show(2024)

** Energy consumption replaced by H_2= H_2 demand for Aviation 101,380 [t] × H_2 calorific value 144,527 [KJ/kg], Conventional fuel replaced by H_2= Energy consumption replaced by H_2 15M [GJ] ÷ Calorific value conversion of conventional fuel 45,375 [KJ/kg]

Sources : Agus; Indonesia to require SAF for flights from 2027 (September 24 in)2024, The price gap and impact analysis are based on JICA consultant team's assumptions and calculations.

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TIMELINE*

	2025–2035: Initiation Phase	2035–2045: Development and Integration Phase
Technology — SAF Production	HEFA : Cost reduction (2025–2030)	HEFA : Both commercialization and large-scale deployment have been achieved. (2030–2045)
	AtJ : Technology development (2025–2030); AtJ : Demonstration (2030–2035)	AtJ: Cost reduction and scale-up to large-scale commercial plants
	FT / PtL : Technology development	FT / PtL : Pilot plant demonstration
Technology — Use	Gradual increase in the SAF blending ratio in line with CORSIA (2025–c. 2040)	Pilot use of 100% SAF-compatible aircraft (c. 2040–2045)
Infrastructure — H_2 / SAF Production	Construction of H_2 plants in renewable-abundant areas, SAF feedstock-abundant areas and near airports	Scale-up of H_2 plants in renewable abundant areas, SAF feedstock abundant areas and near airports
	Construction of SAF plants and establishment of SAF feedstock production/collection systems in SAF feedstock-abundant areas and near airports (Used cooking oil, non-edible plants, etc.)	Scale up of SAF production and SAF feedstock production/collection systems in SAF feedstock abundant areas and near airports (Used cooking oil, non-edible plants, etc.)
Safety & Standards	ISO standards on H_2 quality have already been localized.	Operation and Revision of Standards: Standards are reliably implemented under appropriate monitoring and are regularly revised based on operational feedback
	Development of Standards: SAF quality : Establishment of CORSIA-compliant MRV systems for SAF quality and lifecycle GHG	
	Development of Standards: SAF safety : Development of guidelines for SAF-compatible aircraft	

Economic Incentive (2025–2045)

- **CAPEX Support : e.g., Subsidies and Concessional Finance for H_2 and SAF Plant Construction**
- **OPEX Support : e.g., Support Measures thorough Supply Chain**
- **Scheme : e.g., Establishment of SAF Blending Mandates Based on CORSIA, SAF Credit Implementation**
- **Others : e.g., R&D Support for 100% SAF-Compatible Aircraft**

* Timeline is established based on discussions with the project operators.
Sources : JICA consultant team's interview and analysis

COLLABORATION IDEA IN THE INITIATION PHASE (2025-2035)

Directions of Initiatives in the Initiation Phase

※In RHAN, there are no targets specifically for the aviation sector.

However, Indonesia has the potential and ability to produce, consume, and export SAF via multiple production methods.

- Indonesia offers abundant feedstocks for HEFA, whose TRL is already high.
- Indonesian hub ports will gradually require SAF both for domestic and international airlines.
- Location is suitable to export to major demand countries such as Singapore, Japan, Korea, where needs are expected to rise.

To prepare for SAF mass-production utilizing H_2, supply chain design and demonstration should be conducted.

- In this early stage, it is necessary to build H_2 supply chain toward future application of SAF systems.
- Anticipating this Infra-extension in the future, supply chain design is crucial to make the whole system efficient and strategically functional.

Hypotheses for Collaborative Initiatives in the Initiation Phase

Design and demonstration of entire supply chain in selected areas

Outcome

H_2 entire supply chain is demonstrated where SAF production - transportation infrastructure can be installed

Project Image

Projects to produce SAF and export to adjacent demand countries

- Identifying optimal locations for production sites, transportation routes, and storage zones (export/domestic use)
  - Sumatra can be promising location with abundant feedstocks and geographical advantage
- Development of RE, deployment of electrolyzers, and transportation system via efficient and SAF-convertible carrier
- Sourcing feedstocks such as palm oil residues and CO_2 for scale-up

Initiatives Jointly Implemented by Indonesia and Japan

Design of supply chain

- Selection of promising supply chain which can be integrated with SAF systems
- Economic feasibility study and designing of incentives

Technology application

- Facilities in feedstock pretreatment plant, SAF production
- SAF compatible aircraft

Knowledge sharing

- Guidelines for SAF handling and airport operation

Next Phases

A promising SAF supply chain is designed in the Initiation Phase, which turns into practical demonstration and scale-up in the next phase, and finally commercialized with efficient production methods in the last phase.

Sources : JICA consultant team's interview and analysis

STRATEGIC COLLABORATION AREA

FERTILIZER（GREEN）

Regarding FERTILIZER (GREEN), commercialization is targeted for after 2045. As it is currently difficult to establish a clear outlook for specific actions, the “TIMELINE” and “COLLABORATION IDEA IN THE INITIATION PHASE” sheets have not been created.

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CONCEPT PAPER

Background and Issues

NH_3 for fertilizer production primarily relies on grey H_2, with the overall process generating substantial carbon dioxide emissions.

- In 2019, the total CO_2 emissions of the Pupuk Indonesia Group reached 40.6 million tons.
- Currently, the H_2 used for NH_3 production in Indonesia's fertilizer sector is almost entirely gray H_2 (gas) and the commercial use of clean H_2 has not yet been adopted.
- The production of gray hydrogen for fertilizer relies on natural gas, the price of which has surged, significantly impacting fertilizer manufacturing costs.

Potential of H_2 and NH_3

Clean NH_3 is produced using abundant renewable energy resources from nearby regions, enabling decarbonization.

- The existing facilities can be utilized in the production process of clean NH_3 and the fertilizers derived from it.
- Clean NH_3 has significant potential for use not only in the fertilizers but also in power generation and as marine fuel.
- Switching to clean H_2 could reduce the amount of natural gas currently used as the hydrogen source.

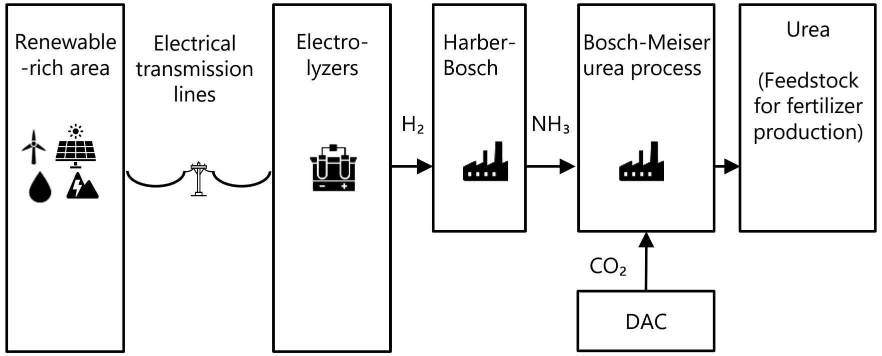
Concept

Overview

Replacing the NH_3 used in fertilizer production with clean NH_3 derived from renewable energy instead of gray NH_3 derived from fossil gas

- Effective utilization of surplus renewable energy resources through clean NH_3 conversion.
- When producing urea from ammonia derived from renewable energy, it is necessary to secure CO_2 using Direct Air Capture (DAC).
  - In conventional methods, the CO_2 generated during gray hydrogen production is used to convert ammonia into urea via the Bosch–Meiser process.

Image



Facility

- NH_3 production plants (Harber-Bosch)
- H_2 production plants
- Electrical transmission lines
- Renewable energy resources
- DAC facilities

Potential Place

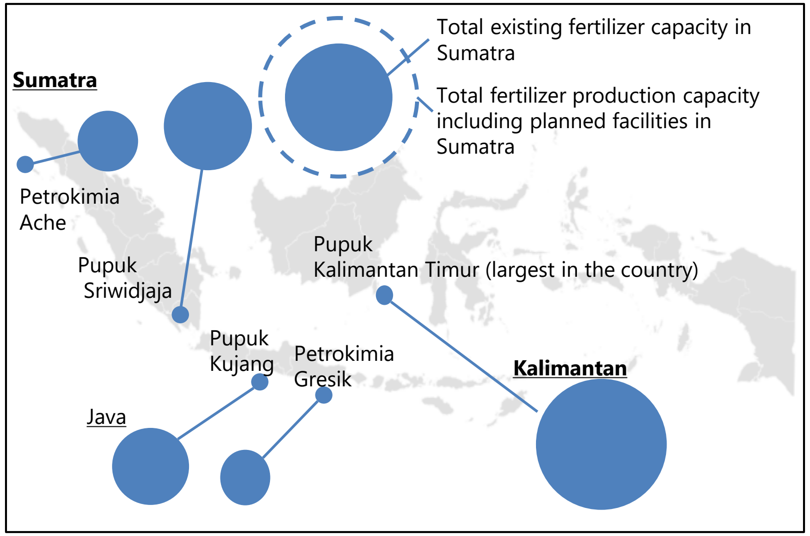
Existing fertilizer plant sites are regarded as potential locations as the system design envisions H_2 production facilities located near fertilizer plants using electricity transmitted through electrical transmission lines,

Near existing fertilizer plants

- Aceh
- South Sumatra
- West Java
- East Java
- East Kalimantan

Production capacity of major fertilizer plants

- Multiple new fertilizer plants are under construction in Sumatra, set to commence operations by 2030.
- The size of each circle represents the capacity.



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IMPACT & KEY CHALLENGES

Key Challenges and Requirements

	Production	Transport/storage	Use
Technology	← **No cost competitiveness for clean H_2; limited current adoption** → • Need for supply chain-wide efficiency and scale-up **Technologies for large-scale production and cost reduction are still under development.**		**Reducing DAC costs is essential.** Clean H_2-based NH_3 and fertilizer production can utilize existing technologies without major modification.
Infrastructure	**Insufficient H_2 and NH_3 production capacity near renewable energy sources or factory sites to meet demand.**	**Incomplete deployment of transmission lines and pipelines for stable delivery of large volumes of renewable energy and H_2 to factories.**	**Large-scale DAC facilities have not yet been constructed.** Compatibility of existing gray hydrogen-based NH_3 production facilities with clean NH_3
Safety& Standards	**Need for fuel quality standards by boiler manufacturers** • Requirements for impurities, specifications, performance standards	**The development of standards and regulations for H_2 pipelines and electrical transmission is insufficient.** • Risks of embrittlement, leakage, safety distance requirements	Standards for the production of NH_3 and fertilizers from clean H_2 are essentially based on existing domestic legislation and industrial codes.
Economic Incentive	← **Shared infrastructure mechanisms to reduce CAPEX and improve utilization are still insufficient.** → • Example: Capacity-based allocation of facility usage rights		**Measures to increase off-takers are not in place.** **Absence of industrial clustering and demand creation near H_2 production sites** **Support measures are needed to address the high costs of DAC.** • CAPEX, OPEX, and policy schemes
	← **Financial support throughout the supply chain is still in the development stage.** → • The price gap between NH_3 (2.2 USD/1kg-H_2) and Gray-NH_3 (1.4 USD/1kg-H_2) will be 0.8 USD/kg as of 2035.*		

Sources: The price gap and impact analysis are based on JICA consultant team's assumptions and calculations.

TABLE OF CONTENTS

PURPOSE

This "GUIDEBOOK FOR COLLABORATION WITH JAPAN" has been prepared to accelerate practical and high-quality collaboration between stakeholders in Indonesia and Japan for the deployment of clean hydrogen and ammonia across the entire value chain, consistent with ongoing bilateral dialogues and regional energy-transition initiatives.

The guidebook provides a structured, overseas-applicable overview of Japan's public support landscape, which is directly and indirectly related to hydrogen and ammonia, summarizing ministries and agencies with related programs and their overviews. For each program, the support requirements, support contents and case examples are organized based on publicly disclosed information from relevant ministries and institutions.

This guidebook can be used by Indonesian public and private stakeholders to identify suitable programs and develop proposals that align with the current eligibility criteria. It can also be used to promote engagement with Japanese counterparts for the co-development of projects related to production, transport, export to Japan, and end-use application development. It is expected to accelerate the development and commercialization of pilot projects within Indonesia's emerging hydrogen and ammonia ecosystem.

Please note that this information is current as of February 2026.

JICA (Japan International Cooperation Agency)

	ODA Loan/Grant*	Technical Cooperation Project (TCP)*	Public-Private Partnerships*
Content	**These schemes provide financial support to developing countries in line with Japan's ODA framework.** • ODA Loan encourages ownership and sustainable financing with repayment obligations. • ODA Grant funds essential infrastructure and services without repayment.	**This scheme provides technical cooperation through expert dispatch, training, equipment provision, project-based cooperation, and development surveys.** • Technical cooperation projects combine multiple components (experts, training, equipment) in a structured project cycle to maximize impact. • Experts are dispatched to partner countries to transfer knowledge and co-develop locally adapted technologies and systems.	**These schemes offer financial and partnership supports to help private companies realize projects in developing countries.** • Private Sector Investment and Finance (PSIF) : JICA provides loans or equity to bridge financing gaps, reduce risks, and enable impactful projects. • JICA Biz : JICA offers advisory, networking, and project design support, leveraging ODA networks to co-create SDG-oriented businesses with companies.
Requirement	**These schemes are available to developing country governments and public entities.** • ODA Loan : Eligible borrowers are developing country governments or public. • ODA Grant : Eligible recipients are mainly governments of low-income countries requiring external funding for basic infrastructure and social development. • Both require official requests from partner governments and approval through Japan's ODA framework, including agreement between the two governments. These schemes follow a structured "project cycle " from planning to ex-post evaluation.	**The scheme supports developing countries that request assistance to enhance their problem-solving capacity with ownership.** • Projects must align with partner countries' development priorities and undergo planning, monitoring, and evaluation based on criteria such as validity, effectiveness, efficiency, impact, and sustainability. • Participation of local stakeholders (government, communities, private sector, NGOs, universities) is encouraged to ensure ownership and long-term results.	**The scheme supports Japanese companies addressing social and economic issues in developing countries with innovative models, products, and technologies.** • Private Sector Investment and Finance (PSIF) : Eligible projects are in developing countries with strong development impact, aligned with national policies, but not financially viable with private funds alone. • JICA Biz : Eligible companies are with organizational commitment and resources for overseas expansion, offering innovations that contribute to the SDGs.
Case Example	**Lumut Balai Geothermal Power Plant Project** – Location : Indonesia – ODA Loan, Construction of the geothermal power plant.  Source : JICA HP, Lumut Balai Geothermal Power Plant Project	**Project for the Design of Financial Mechanisms for the New Green Hydrogen Economy** – Location : Paraguay – TCP, Establishment of financing mechanism for green hydrogen. **Master Plan for Energy Transition Management Project** – Location : Indonesia – TCP, Capacity building for formulating masterplan for energy transition of PLN.	**Monsoon Wind Power Project** – Location: Laos – PSIF, Project finance for the wind power project. **The Effective Utilization of Natural Gas Using Smart Gas Meters in Indonesia** – Location: Indonesia – JICA Biz, Project finance for the wind power project.

* These schemes can be applied for H_2 and NH_3-related projects.
Sources : JICA HP

JICA'S COOPERATION IN ENERGY SECTOR IN INDONESIA
（As of February 2026）

Objective : To realize a stable, reliable, affordable and sustainable power supply with the achievement of the de-carbonization in Indonesia through Multi–Pathway Transition.

Blue：Ongoing/Planned
Red：Under consideration
Green：Completed

Multi-Pathway Approach

1. Renewable Energy

Hydroelectric Power Plant
- Asahan 3 (ODA Loan)
- Peusangan (ODA Loan)

Geothermal Power Plant
- Lumut Balai (ODA loan)
- Hululais (E/S* ODA Loan, ODA Loan)
- The project to develop medium-and long-term geothermal development policy in Indonesia (TCP**)

Waste to Energy
- Waste to Energy : Legok Nangka (Transaction Advisory with IFC)
- Project for Capacity Development of Municipal Solid Waste Management

Other
- Solar power survey on remote islands (North Kalimantan, South Sulawesi)

2. Energy Transition

Technical Cooperation
- Dispatch of experts to MEMR and PLN
- Master Plan for Energy Transition Management Project for PT.PLN (TCP)

ODA Loan
- Energy transition policy support loan (ODA Loan concept)

Survey
- Data collection survey for promoting hydrogen society in Indonesia (Study)
- Data collection survey for ASEAN Power Grid (Study)

3. Capacity Development

- Capacity development of MEMR, PLN, Pertamina staffs (Experts, Japan Training, Site Visit etc.)

* E/S=Engineering service
** TC=Technical Cooperation Project

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The content and requirement are based on what was implemented in FY2025 and may be revised in the following fiscal year.

METI (Ministry of Economy, Trade and Industry)

	Global South Future-Oriented Co-Creation Project, Large-Scale demonstration (ASEAN)*	Global South Future-Oriented Co-Creation Project, Feasibility Study and Small-Scale Demonstration*
Content	**This scheme provides subsidies covering part of the expense required for companies to carry out demonstration projects in ASEAN.** • Maximum support rate : 1/2 for large companies, 2/3 for small companies under the guidelines • Support amount : From 500 million yen up to 4 billion yen**	**This scheme provides subsidies covering part of the costs for feasibility study and demonstration projects in global south.** • Support maximum rate : 1/2 for large companies, 2/3 for small companies under the guidelines • Support amount : Upper limit of 100 million yen for FS and 500 million yen for demonstration projects**
Requirement	**This scheme aims to leverage the growth potential of markets in the so-called Global South countries (limited to ASEAN member states for this scheme) by addressing the challenges they face, thereby strengthening economic partnerships with these countries and delivering benefits to the host nations where the projects are implemented. In addition, the program seeks to revitalize Japan's domestic industries through the creation of innovation and the enhancement of supply chain resilience.** • Only Japanese companies are eligible to apply.	**This scheme aims to subsidize part of the costs required for feasibility studies (FS) and small-scale demonstration projects conducted by Japanese companies for overseas deployment of infrastructure and related businesses. Through addressing challenges faced by Global South countries and utilizing the growth potential of markets in those regions, the program seeks to promote innovation and revitalize Japan's domestic industries, while also strengthening economic partnerships with the Global South.** • Only Japanese companies are eligible to apply.
Case Example	**Clean ammonia project "GAIA"** • Basic information – Location : Aceh, Indonesia – Company : Itochu, Toyo Engineering, Pupuk • Objective – Joint development of clean ammonia supply chain	**Energy management survey project in Vietnam** • Basic information – Location : Hai Phong, Vietnam – Company : Tokyo Electric Power Grid Co., Ltd., Deep C Green Energy • Objective – Promotion of renewable energy, hydrogen production, etc.

* This scheme also covers regions outside ASEAN; however, as this material is intended to promote collaboration between Japan and Indonesia, only these two schemes are introduced here..
** 500 million yen = 3.3 million USD, 4 billion yen = 26.7 million USD, 100 million yen = 0.67 million USD (150 yen=1 USD)
Sources : METI HP, Global South Future-Oriented Co-Creation Project HP, Deep C Industrial Zones HP

Support focusing on the price gap and support for hub development* have already passed their application deadlines.

METI (Ministry of Economy, Trade and Industry) JOGMEC (Japan Organization for Metals and Energy Security)

	Support Focusing on the Price Gap*	Support for Hub Development*
Content	**The support focusing on the price gap will be provided with the price gap between hydrogen and its derivatives, and conventional fuels taken into account.** • The cost of low-carbon hydrogen is still high, and the gap between the prices of hydrogen and conventional fuels is huge. Therefore, subsidies will be targeted at the cost related to the domestic production of hydrogen and its derivatives, or the cost related to overseas production and maritime transportation.	**The hub development program is targeted at infrastructure development, including tanks and pipelines to be built for the transportation and storage of hydrogen, etc.** • Subsidies are awarded for part of the FEED (Front-End Engineering Design), engineering and construction costs of domestic transport and storage facilities necessary for multiple companies to utilize low-carbon hydrogen and its derivatives.

Requirement

Eligible companies : Low-carbon hydrogen and derivatives suppliers in the projects selected under Hydrogen Society Promotion Act

Eligible companies : Those certified under Hydrogen Society Promotion Act and act as low-carbon hydrogen and derivatives suppliers

- **Under the Hydrogen Society Promotion Act, for both "support focusing on the price gap" and "support for hub development," METI is responsible for selecting the projects, while subsidies will be granted by JOGMEC.**

The following criteria are established with the aim of creating and expanding supply chains that are proactive and are expected to be self-reliant.

Business plans must be economically and rationally viable, and contribute to strengthening the international competitiveness of Japanese industry concerning the supply and utilization of low-carbon hydrogen and its derivatives.

If the applicant wishes to obtain support focusing on the price gap or support for hub development (hub development program),

- the plan must be formulated and submitted jointly by the supplier and the users;
- the supply of low-carbon hydrogen and its derivatives is expected to start within a certain period of time and continue for a certain period of time or longer; and
- the users are expected to make new capital investment or bring about business innovation for utilizing low-carbon hydrogen and its derivatives.

The ports and roads where pipes or storage tanks will be installed are suitable in light of the port plans and the status of utilization of land, such as road situations.

Case Example

Support Focusing on the Price Gap*	Support for Hub Development*
Two projects have been approved under this scheme. **(As of November 2025)** 1. Production of green hydrogen to be used for heating furnaces for iron and steel materials by Toyota Tsusho, Eurus Energy Holdings, Iwatani, Aichi Steel 2. Production of low-carbon ammonia through chemical recycling of plastics to supply acrylonitrile by Resonac, Nippon Shokubai	**(As this scheme was newly launched with no other precedents yet.)**

Sources : JOGMEC HP, SOMPO HP, METI Recent developments in hydrogen in Japanese, JOGMEC, For the establishment of supply chain for low-carbon hydrogen and its derivatives, JOGMEC will administer "Support focusing on the price gap" and "Support for the development of hubs", METI, Hydrogen Society Promotion Act Enacted Toward a Forthcoming Hydrogen-based Society Part 2: Utilization of Clean Hydrogen

JOGMEC (Japan Organization for Metals and Energy Security)

Equity Capital and Liability Guarantees

Content

Financial support for hydrogen production and storage projects by Japanese companies for stable hydrogen supply to Japan

- Equity capital and liability guarantee covering up to 50% of the required funds borne by Japanese companies, extendable to 75% if deemed essential by JOGMEC.

Requirement

The scheme supports Japanese companies and their overseas affiliates engaging in H_2 and its derivatives such as NH_3 and e-fuels production and storage projects based on the revision of JOGMEC Act.

- Japanese companies may use the scheme through foreign firms in which they have invested and are involved in management, or through subsidiaries of such foreign firms, provided that they directly or indirectly hold the majority of voting rights and Japanese people occupy the majority of directors.
- The scheme covers not only H_2 production and storage projects, but also rights acquisition and overseas M&A by Japanese companies.

Case Example

Equity investment in US-based e-fuel producer HIF global

- Basic information
  - Location : Texas, United States
  - Co-investment with Idemitsu Kosan
- Objective
  - To accelerate the establishment of supply chains of hydrogen including e-Fuels
- Estimated amount of equity financing
  - Approx. USD 36 million
- Approval has been made in accordance with JOGMEC's technical, economic, and business-environment criteria and the consent from the Minister of Economy, Trade and Industry has been obtained.

Source：JOGMEC HP, JOGMEC gains equity share of HIF Global LLC, one of the leading e-Fuels companies in the world

Sources : JOGMEC HP, SOMPO HP, METI Recent developments in hydrogen in Japanese, JOGMEC, For the establishment of supply chain for low-carbon hydrogen and its derivatives, JOGMEC will administer "Support focusing on the price gap" and "Support for the development of hubs"

The support schemes by NEDO are intended for international collaboration projects with Japan.

NEDO (New Energy and Industrial Technology Development Organization)

International Demonstration Project on Japan's Technologies for Decarbonization and Energy Transition

Content

This scheme supports the overseas demonstration of Japan's advanced technologies, including hydrogen and ammonia, through four phases by verifying their effectiveness and promoting global deployment. Demonstration phase : project scale up to JPY 4 billion, partial cost-sharing for three years.

- [1] Feasibility Study (FS)
- [2] Front End Engineering Design (FEED)
- [3] Demonstration
- [4] Follow-up

Requirement

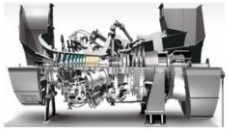
Target technologies must contribute to decarbonization and energy transition.

- Broad scope: hydrogen and ammonia, plus renewable energy, circular economy, AI/robotics, biotech, automotive, batteries, energy efficiency, and more.
- For hydrogen and ammonia, this covers production, storage, transport, utilization, and related fuel cell technologies.

Case Example

The demonstration project for hydrogen gas turbine power generation to realize hydrogen power generation in Europe

- Operate by co-firing or mono-firing natural gas and hydrogen at any ratio from 0 to 100% in Germany.



30 MW class gas turbine

Source : Kawasaki Heavy Industry

Program to Facilitate Overseas Promotion of Low Carbon Technology Through the Joint Crediting Mechanism (JCM*)

Content

This scheme supports overseas demonstrations of Japan's advanced low-carbon technologies under JCM, providing up to JPY 1 billion per project for design, demonstration, and quantification phases to promote global diffusion and contribute to Japan's NDC targets.

- It also includes initiatives such as developing new JCM methodologies, providing quantification support, and facilitating private-sector JCM project formation to expand future JCM implementation.

Requirement

Projects must utilize proven Japanese low-carbon technologies and systems capable of measurable GHG reductions.

- The target technologies and systems must be related to the suppression of energy-derived CO2 emissions.
- Procedures related to the issuance of JCM credits must be implemented.
- It must be possible to issue JCM credits of 1,000 tons of CO2 or more during the Demonstration Project.

Case Example

The demonstration of producing green hydrogen utilizing surplus electricity from renewable energy and providing system solutions in the Socialist Republic of Viet Nam, FS phase in 2025

Research and Development Program for Promoting Innovative Energy and Environmental Technologies Through International Collaboration

Content

This scheme supports international joint R&D between Japanese and foreign research institutions in the clean energy field to develop innovative technologies toward 2040 practical use, providing up to JPY 50 million per year for up to three years.

Requirement

Eligible projects must involve Japan-based research organizations collaborating with overseas institutions on clean energy topics or renewable energy and undergo NEDO's stage-gate and expert evaluations.

- Target fields include energy conservation, new energy, next-generation batteries and hydrogen, smart communities, and other clean energy and environmental technologies.

Case Example

International Joint Research on Intermediate Temperature Solid Oxide Electrolysis Cell Based on Innovative Cells Design

- Kyushu University, commissioned by NEDO, has entered into joint research agreements with several European institutions — Forschungszentrum Jülich (Germany), the Paul Scherrer Institute (Switzerland), and Imperial College London (United Kingdom) — to carry out collaborative research.

* Joint Crediting Mechanism (JCM)

Sources : NEDO HP

JBIC (Japan Bank for International Cooperation)

Overseas Investment Loans (OIL)

Content

Overseas investment loans support Japanese foreign direct investments.

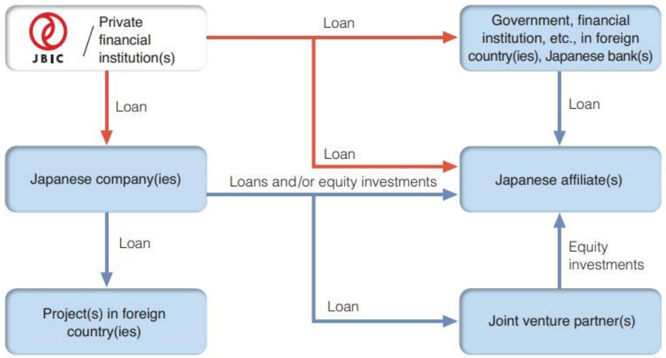
- OIL is for projects aimed at developing or securing interests in overseas resources that are strategically important to Japan (including **hydrogen**).
- JBIC provides two-step loans (TSLs) to support the overseas business of Japanese companies, including mid-tier enterprises and medium-sized enterprises.

Requirement

Japanese companies must be involved in the projects that OIL is aimed for.

(For more details, please contact JBIC.)

Possible Scheme



Example

- **Project :** Green ammonia production by a Joint Venture established by Japanese and Indonesian Companies.
- **Loan** : JBIC can provide loan (1) directly to the Joint Venture or (2) to the Japanese and Indonesian companies that invest equity to the Joint Venture. JBIC's loan can be used for the purpose of the certain project.

Import Loans

Content

Import loans support imports of strategically important goods by Japanese companies and cases where Japanese companies or Japanese affiliates receive natural resources in countries where they do business.

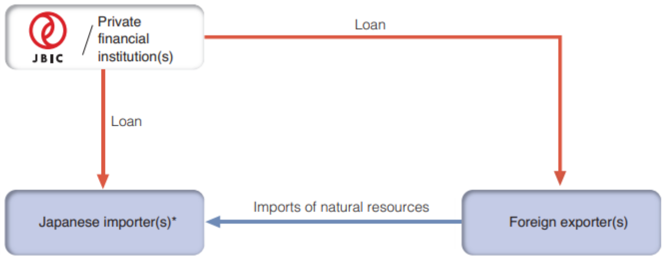
- **Important goods include "hydrogen" and "ammonia used as fuel".**

Requirement

Japanese companies must import "important goods" to Japan or countries where Japanese companies or their affiliates do business.

(For more details, please contact JBIC.)

Possible Scheme



* Including cases where Japanese companies or Japanese affiliates receive natural resources in countries where they do business

Example

- **Project :** Export of green ammonia to a Japanese company in Japan.
- **Loan** : JBIC can provide loan (1) to the Japanese importer or (2) to the Indonesian green ammonia exporter.

Export Loans

Content

Export loans are provided to overseas importers and financial institutions to support finance exports of Japanese products.

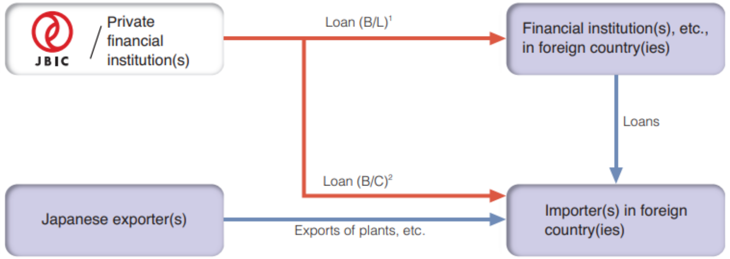
- Terms and conditions of export loans are determined based on the Arrangement on Officially Supported Export Credits (OECD Arrangement).

Requirement

Japanese products must be imported by importers in foreign countries.

(For more details, please contact JBIC.)

Possible Scheme



1. Loan to foreign financial institutions (bank-to-bank loan or "B/L").
2. Loan to foreign importers (buyer's credit or "B/C").

Example

- **Project :** Import of Japanese electrolyzers by an Indonesian company.
- **Loan** : JBIC can provide loan (1) directly to the Indonesian importer or (2) to financial institutions which provide loans to the Indonesian importers. The loan amount should not exceed the value of an export contract or technical service contract, and excludes the down payment.

JBIC (Japan Bank for International Cooperation)

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Untied Loans

Content

Untied loans are intended

(1) to finance projects and the import of goods by foreign countries, or

(2) for such countries to achieve equilibrium in their international balance of payments, or

(3) to stabilize their currencies,

(4) to finance overseas businesses of foreign companies ("eligible foreign companies") that have become part of supply chains or industrial platforms of strategically important goods or technologies essential for Japan's economic activities and the lives of the people of Japan.

Capital procured from untied loans is used to:

(1) maintain and expand trade with and direct investment from Japan;

(2) secure stable supplies of energy and mineral resources for Japan;

(3) promote business activities of Japanese companies;

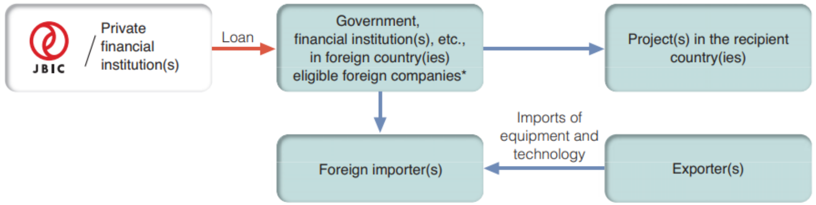
(4) finance projects having significant effects on global environmental preservation; and

(5) finance projects maintaining order in international financing.

Requirement

Loans are not conditional on investments or procurement of equipment and materials from Japan. (For more details, please contact JBIC.)

Possible Scheme



Example

- **Project :** Construction of Port for Hydrogen Export to Japan by an Indonesian Company.
- **Loan** : JBIC can provide loan to the Indonesian Company that construct the port that is indispensable for hydrogen export from Indonesia to Japan.

Equity Investments

Equity investments are capital contributions to companies where Japanese companies have equity stakes to undertake.

In principle, equity investments take the following forms.

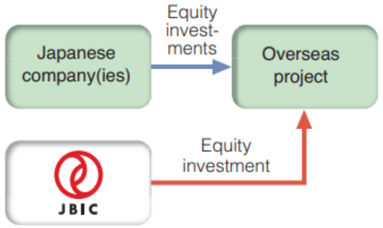
(1) Japanese companies make equity investments in an overseas project; or

(2) Japanese companies acquire equity interests in a foreign company to form a business alliance

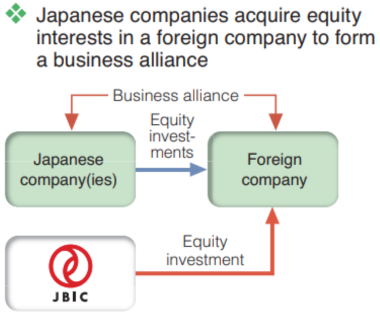
Japanese companies must have equity stakes to companies that JBIC invest equity.

(For more details, please contact JBIC.)

(1) Japanese companies make equity investments in an overseas project;



(2) Japanese companies acquire equity interests in a foreign company to form a business alliance



- **Project :** Green ammonia production by a Joint Venture established by Japanese and Indonesian Companies.
- **Equity Investment** : JBIC can invest equity to the Joint Venture.

NEXI (Nippon Export and Investment Insurance)

Content

Export Credit Insurance

In cases where Japanese exporters export goods to, engage in intermediary trade, or provide technology such as construction work, this insurance covers losses due to i) force majeure such as war, revolution, terrorism, import restriction/prohibition, and natural disasters, or ii) inability to ship goods due to bankruptcy of the counterparty, etc., as well as losses resulting from inability to collect payment after the goods have been shipped or after the technology has been provided.

Overseas Investment Insurance

This insurance covers losses incurred by Japanese companies with a subsidiary or a joint venture in a foreign country, if the subsidiary or joint venture is forced to discontinue business due to force majeure such as war, terrorism, and natural disasters. In addition, when a subsidiary of a Japanese company conducts business by establishing sub-subsidiaries in a country where the insurance also covers losses incurred if dividends are unable to be remitted to Japan or overseas subsidiaries, etc. due to the prohibition of foreign currency exchange or the subsidiary is located or in third countries, respectively, this insurance covers losses if any of the sub-subsidiaries are forced to discontinue business due to force majeure such as war, terrorism, and natural disasters, even if the other sub-subsidiaries are able to continue business.

Buyer's Credit Insurance/Overseas Untied Loan Insurance

Buyer's Credit Insurance

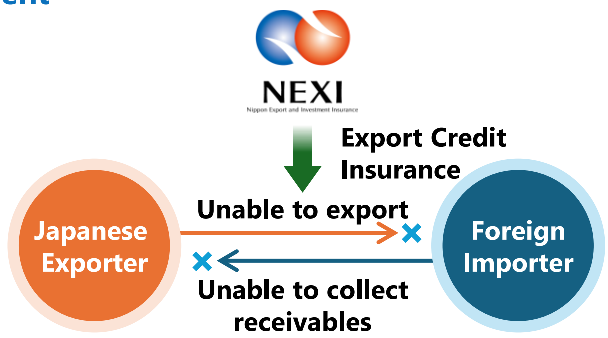
In cases where a Japanese bank or financial institution provides a loan, etc. (including purchase of bonds and assumption of guarantee obligations) to a foreign importer purchasing goods from Japan, this insurance covers losses incurred if the Japanese bank is unable to receive repayment of the loans due to i) war, revolution, prohibition of foreign currency exchange, suspension of remittance, or ii) bankruptcy or default of the importer.

Overseas Untied Loan Insurance

This insurance covers losses incurred by Japanese companies, banks, etc. that provide foreign governments and companies with business funds (which are not tied to export from Japan) for overseas projects, or that purchase bonds issued by foreign governments or companies for the purpose of financing, if the loans, etc. are not redeemed due to i) war, revolution, prohibition of foreign currency exchange, and suspension of remittance, or ii) bankruptcy or default of the borrower or the bond issuer.

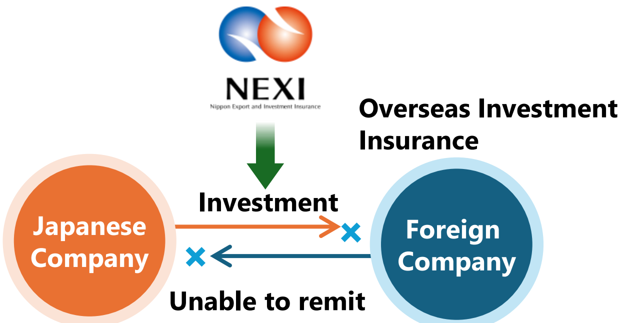
Requirement

Export Credit Insurance



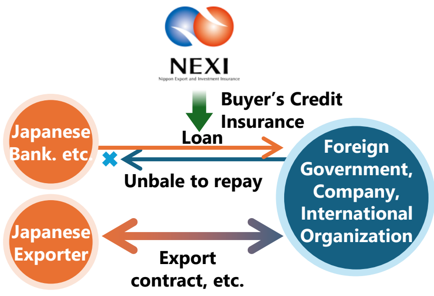
- Support for exports by Japanese companies
- Covers pre-shipment and post-shipment insured accidents for both political and commercial risks.

Overseas Investment Insurance



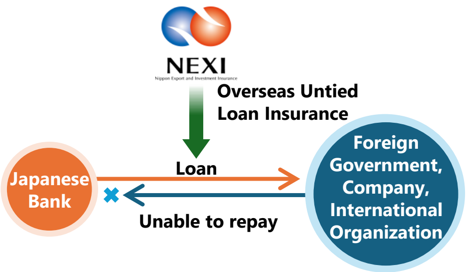
- Support for overseas investment by Japanese companies
- Does not cover commercial risk
- Covers losses such as inability to remit funds and inability to continue business due to political risk.

Buyer's Credit Insurance



- Support for exports by Japanese companies
- Covers the private bank portion of the co-financing with JBIC.
- Terms of support follows the OECD Arrangement.

Overseas Untied Loan Insurance



- Support for the overseas business expansion of Japanese companies
- The project is beneficial to Japan and Japanese companies (Japan Interest (JI)).

Sources : NEXI HP

DBJ (Development Bank of Japan)

Green Investment Promotion Fund

Content

This scheme as one category under the special investment operations aims to accelerate Japan's transition toward a carbon-neutral society by supplying equity and mezzanine capital to green and decarbonization projects.

- The fund was created in February 2021, based on the government's "Comprehensive Economic Measures to Protect the Lives and Livelihoods of the People" (Cabinet Decision, December 2020). It supports a wide range of initiatives contributing to carbon neutrality, such as renewable energy, energy efficiency, next-generation storage, and industrial decarbonization.
- DBJ co-invests with private financial institutions to provide risk capital, enhancing the flow of long-term investment into climate-related projects that would otherwise face financing gaps.
- As of March 2025, the fund's investment track record includes 19 projects totaling JPY 106.6 billion.
- Examples of Supported Fields
  - 1. Renewable energy projects (e.g., solar, wind, biomass) 2. Businesses utilizing fuel-efficient technologies 3. Next-generation battery and storage system development 4. Projects contributing to decarbonization or significant CO_2 reduction 5. Transition investments in carbon-intensive industries aiming for low-carbon transformation 6. Other initiatives aligned with achieving carbon neutrality

Requirement

Applicants must operate or invest in projects that make contributions to Japan's carbon-neutral goals.

- Japanese companies engaged in promoting renewable energy, improving energy efficiency, or advancing the decarbonization of industrial processes are eligible.
- Investment proposals are reviewed using the DAC6 evaluation framework, adapted from the OECD's international development criteria, ensuring quantitative and qualitative policy assessment
  - Relevance, coherence, effectiveness, impact, sustainability and efficiency.

Case Example

TSUBAME BHB

- Basic information
  - Location : Japan
  - Date : July 25, 2022
- Objective
  - Support the commercialization and deployment of an on-site ammonia production and supply system
- Content
  - The investment was made jointly with partner companies, with a total co-investment amount of about JPY 4 billion.

Investment in Japan Suiso Energy,Ltd.

- Basic information
  - Location : Japan
  - Date : August 28, 2025
- Objective
  - Support commercialization of the liquefied hydrogen supply chain
  - Realize carbon neutral society in 2050
- Content
  - This investment is a joint investment with other 5 companies.

Source : DBJ HP, Japan Suiso Energy, "A third-party allotment was carried out to develop a liquefied hydrogen supply chain (in Japanese)"

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APPENDIX

COLLABORATION PROJECT OPPORTUNITIES

(As of February 2026)

This information was compiled by JICA through its own interviews with PT PLN, PT Pertamina, and PT Pupuk Indonesia, listing projects where these companies will explore opportunities for collaboration with Japanese stakeholders.
Please note that this information is current as of February 2026.

COLLABORATION PROJECT OPPORTUNITIES (As of February 2026)

KEMENTERIAN ESDM

JICA

A list of potential projects submitted by Indonesian players for further collaboration in Hydrogen and Ammonia

Player	Project Name	Project Concept	Location	Technology Tag
PLN	**De-dieselization by hydropower-derived H_2**	Distributing H_2 to around 10 islands dispersed within a certain area	• East Jawa	• HFCG, HICE • H_2 carrier
PLN	**PV BESS Hydrogen for de-dieselization**	Bringing BESS and FCVs in islands for self production & consumption	• NTB medang island • East java Gili Ketapang • Rengit island	• BESS • FCV
PLN	**Hydrogen trans Jawa FCEV and HICE (H_2 ICE)**	Utilizing FCEV(Fuel cell electric vehicle) & HICE (H_2 internal combustion engine) in trans Jawa	• Jawa	• FCV • HICE
PLN	**Kujang H_2 plant for fertilizer with Pupuk**	Building H2 plant with capacity of 2 ton/day for fertilizer production with Pupuk Indonesia	• West java Kujang	• Electrolyzer • Solar PV
PLN	**H_2 Refueling stations**	Installing 18 HRS in 150 bar all across Java island	• 18 locations in Java	• HRS
Pertamina	**RU VI Balongan Blue Hydrogen Ecosystem**	Expanding current H_2 plant combining with CCS systems	• West Jawa	• Blue H_2 • CCS
Pertamina	**Ulubelu's Green Hydrogen Utilization**	Bringing H_2 to Tanjung Sekong for port-internal use cases	• Lampung, Sumatra	• HFCG • H_2 Transport
Pertamina	**Flare Gas to Low Carbon Hydrogen**	Turning flare gas (methane) into H_2 and Carbon biproduct	• East Jawa	• Turquoise H_2 • Carbon recycling
Pertamina	**Green H_2-derived SAF production in Sumatra**	Utilizing geothermal to produce H_2 and export to demand countries	• Sumatra	• HEFA/AtJ/FT/PtL
Pupuk	**Green Ammonia Initiative from Aceh (GAIA)**	Production low-carbon NH_3 utilizing renewable energy within existing NH_3 facilities	• Lhokseumawe, Aceh	• Green NH_3 • Electrolyzer
Pupuk	**Hybrid Green Ammonia Gresik**	Utilizing solar captive power to produce low-carbon NH3 in existing NH_3 facilities	• Gresik • East Java	• Green NH_3 • Solar PV, Electrolyzer
Pupuk	**Blue Ammonia Masela**	Developing large-scale blue NH_3 using natural gas from the Masela Block combined with CCS	• Yamdena Island	• Blue H_2, NH_3 • CCS • ATR / SMR
Pupuk	**Blue Ammonia Aceh**	Producing blue NH_3 by utilizing natural gas and CO2 storage within the area	• Lhokseumawe, Aceh	

APPENDIX

NUMERICAL DATA FOR IMPACT ANALYSIS

IMPACT ANALYSIS : ESTIMATED SOCIO-ECONOMICAL IMPACT OF EACH CONCEPT IN TERMS OF ENERGY SECURITY, CARBON NEUTRAL AND ECONOMIC IMPACT

KEMENTERIAN ESDM

JICA

Legend: Infra. Investment / Earning from export

Estimation for the year of 2035

Concept	①Energy Security (Contribution to Energy Sufficiency Rate)	②Carbon Neutral (CO_2 Reduction Rate)	③Economic Impact (Million USD / Year)
De-dieselization by Hydrogen based on RHAN	1.05M GJ(0.01%)	0.129M t (0.0084%)	470
Land Transport based on RHAN	0.197M GJ(0.001%)	0.024M t (0.0015%)	320
Maritime Transport based on RHAN	0.048M GJ(0.0004%)	0.007M t (0.0004%)	1.5
Overseas Exports based on RHAN	N/A	N/A	280 (Infra. Investment) 270 (Earning from export)
Power Generation based on RHAN	N/A	**0.600M t (0.04%)**	59
Aviation (SAF) based on the SAF Action plan*	6.70M GJ (0.06%)	0.79M t (0.05%)	83 (Infra. Investment) 72 (Earning from export)

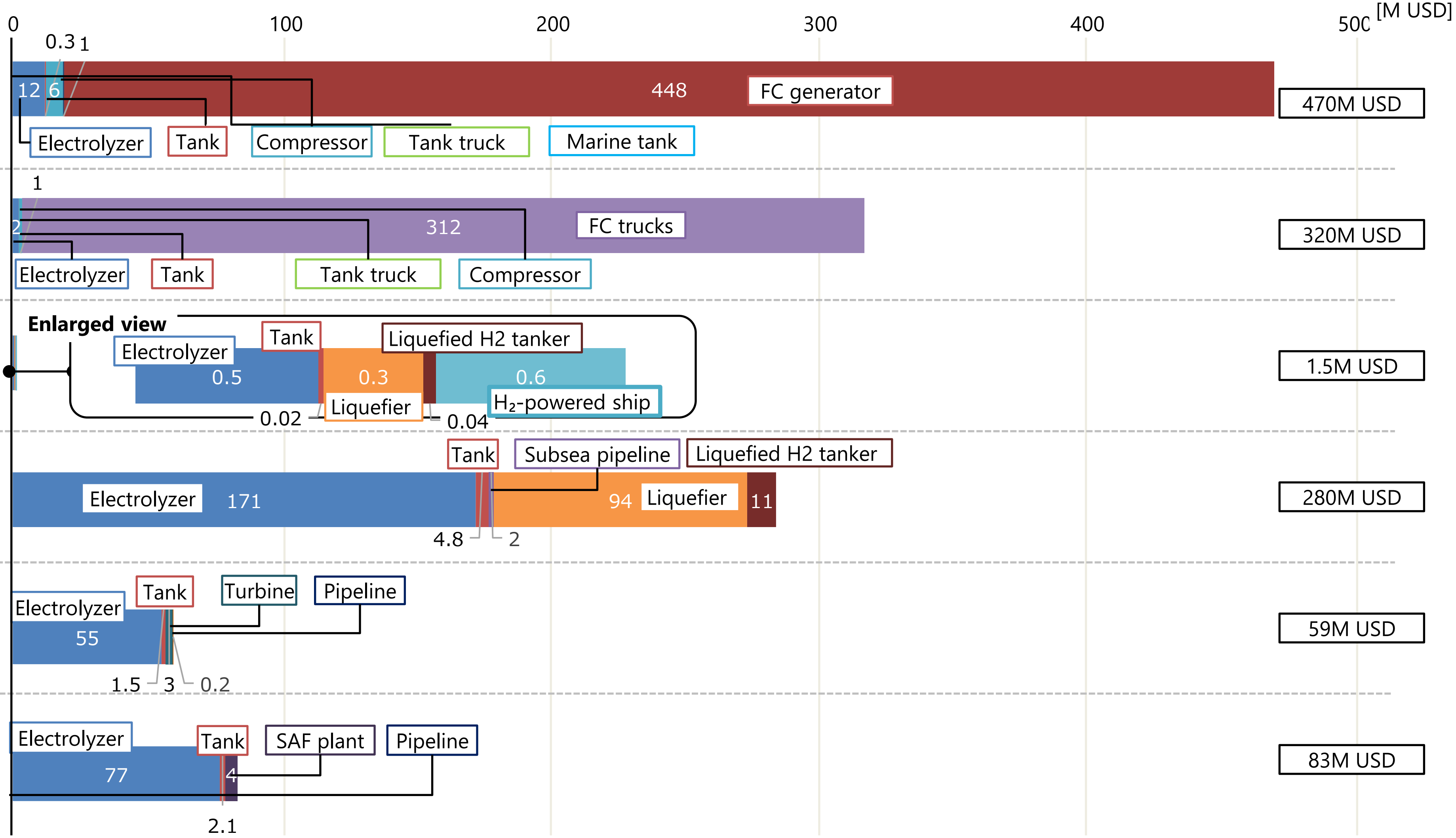
Regarding the SAF estimation, the hydrogen demand was calculated based on the SAF Action plan.

* Since RHAN lacks SAF projections for 2035, estimates based on Indonesia's ministry of investment's remark about SAF Action Plan(2025-2029) at Bali international Air show(2024)

Source: The impact analysis is based on JICA's consultant team assumptions and calculations.

ECONOMIC IMPACT : BREAKDOWN BY INFRASTRUCTURE

Concept	H_2 Demand	Infrastructure Investment Impact (This Analysis Assumes H_2 Production via Renewable Electrolysis, but Other Methods Such as CCS and Biomass Reforming Can Also Be Considered.)
De-dieselization by Hydrogen based on RHAN	15,790 t	470M USD
Land Transport based on RHAN	2,961 t	320M USD
Maritime Transport based on RHAN	726 t	1.5M USD
Overseas Exports based on RHAN	226,761 t	280M USD
Power Generation based on RHAN	72,889 t	59M USD
Aviation (SAF) based on SAF Action plan*	101,380 t	83M USD

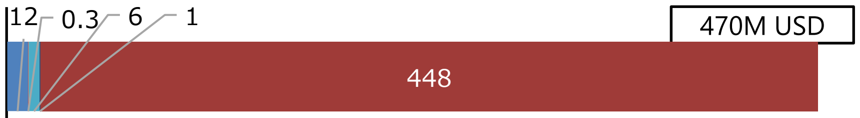


ECONOMIC IMPACT : DETAILS OF INFRASTRUCTURE INVESTRMENT IMPACT

KEMENTERIAN ESDM

Concept	Infrastructure Investment Impact	Additional Information

De-dieselization by Hydrogen based on RHAN

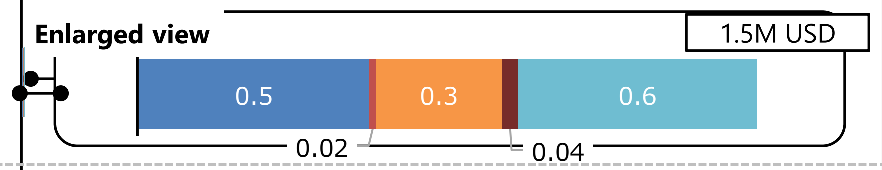


By 2035, H_2 demand will already be significant (15,789 t), and since the FC generator relies on platinum catalysts, which account for most of the cost and remain expensive with limited price reduction potential, resulting in a substantial impact.

Land Transport based on RHAN

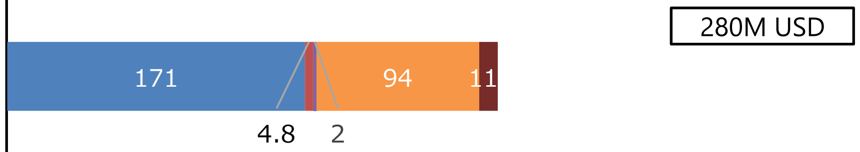
Since the overall H_2 demand is relatively small (2,961 t), the impact on H_2 production and supply infrastructure is limited. In contrast, the impact of FC trucks is significant, as their cost is much higher (200M USD) compared to conventional trucks (80M USD).

Maritime Transport based on RHAN



H_2 fueled ships are expensive, but by 2035 H_2 demand in ships will be limited to 726 t. As a result, the overall impact on infrastructure investment will be small.

Overseas Exports based on RHAN



For large-scale transportation such as exports, high transport efficiency is required; therefore, this estimation assumed liquid H_2 carriers. Depending on future technological developments, alternatives such as MCH, NH_3 or H_2 storage alloys may also be chosen.

Power Generation based on RHAN

Although various types of infrastructure such as turbines, tanks, and pipelines, will be utilized, the impact itself will remain limited, given that hydrogen demand is still relatively modest (72,899 t).

Aviation (SAF) based on SAF Action plan*

In 2035, SAF will be mainly based on HEFA and AtJ, and H_2 demand for SAF will still be limited. Infrastructure investment will mainly focus on manufacturing facilities for SAF plant and electrolyzer.

* Since RHAN lacks SAF projections for 2035, estimates based on Indonesia's ministry of investment's remark about SAF Action Plan(2025-2029) at Bali international Air show(2024)

Source: The impact analysis is based on JICA's consultant team assumptions and calculations.

APPENDIX

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ABBREVIATIONS AND ACRONYMS

AB	Akselerasi & Berkelanjutan (Acceleration & Sustainability)
ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
AtJ	Alcohol-to-Jet
BAPPENAS	Badan Perencanaan Pembangunan Nasional（Ministry of National Development Planning in Indonesia)
BRIN	Badan Riset dan Inovasi Nasional (National Research and Innovation Agency of Indonesia)
CAAF	Conference on Aviation and Alternative Fuels
CAPEX	Capital Expenditure
CCS	Carbon Capture and Storage
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
DBJ	Development Bank of Japan
DI	Dream Incubator
DX	Digital Transformation
E/S	Engineering Services
EPC	Engineering, Procurement and Construction
EV	Electric Vehicle
FC	Fuel Cell
FCV	Fuel Cell Vehicle
FEED	Front-End Engineering Design
FS	Feasibility Study
FT	Fischer-Tropsch
GHG	Greenhouse Gas
GX	Green Transformation
HEFA	Hydroprocessed Esters and Fatty Acids
HFCG	Hydrogen Fuel Cell Generator
IaaS	Infrastructure as a Service
IBRD	International Bank for Reconstruction and Development
ICAO	International Civil Aviation Organization
IDA	International Development Association
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
IFHE	Indonesia Fuel Cell and Hydrogen Energy
IMO	International Maritime Organization
IN	Inisiasi (Initiation)
ISO	International Organization for Standardization
JBIC	Japan Bank for International Cooperation
JCM	Joint Crediting Mechanism
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
JOGMEC	Japan Organization for Metals and Energy Security
KPI	Key Performance Indicator
LEAD	LEADING TECHNOLOGIES & BUSINESSES, ENVIRONMENT & ENERGY, ALLIANCE, DEVELOPMENT
LNG	Liquefied Natural Gas
LOI	Letter of Intent
MaaS	Mobility as a Service
MCH	Methylcyclohexane
MEMR	Ministry of Energy and Mineral Resources of Indonesia
METI	Ministry of Economy, Trade and Industry (Japan)
MIGA	Multilateral Investment Guarantee Agency
MLIT	Ministry of Land, Infrastructure, Transport and Tourism (Japan)
MOC	Memorandum of Cooperation
MRV	Measurement, Reporting and Verification
NDCs	Nationally Determined Contributions
NEDO	New Energy and Industrial Technology Development Organization
NEXI	Nippon Export and Investment Insurance
NGO	Non-Governmental Organization
ODA	Official Development Assistance
OPEX	Operating Expenditure
PI	Pengembangan & Integrasi (Development & Integration)
PLN	Perusahaan Listrik Negara (State Electricity Company of Indonesia)
PR	Public Relations
PSIF	Private Sector Investment and Finance (PSIF)
PT	Perseroan Terbatas
PtL	Power-to-Liquid
R&D	Research and Development
RHAN	Peta Jalan (Roadmap) Hidrogen dan Amonia Nasional (Indonesia's National Hydrogen and Ammonia Roadmap)
SAF	Sustainable Aviation Fuel
SDGs	Sustainable Development Goals
SLLP	Sustainability-Linked Loan Principles
SPTs	Sustainability Performance Targets
TC	Technical Cooperation

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