KELAYAKAN HIDROGEN DAN AMMONIA DALAM SISTEM KETENAGALISTRIKAN INDONESIA DAN PEMBELAJARAN DARI PILOT PROJECT PLN

Jakarta, 12 Septembers 2025

RICKY CAHYA ANDRIAN
Divisi Pengembangan Bisnis Korporat dan Investasi
PT PLN (Persero)

LATAR BELAKANG PLN MEMBANGUN EKOSISTEM H2

1.Hidrogen adalah molekul yang berlimpah di bumi dan bersih

2.Komunitas Global meyakini bahwa hydrogen adalah salah satu kunci utama mencapai NZE

3.Pada saat PLN mulai membangun ekosistem hydrogen, belum ada Perusahaan maupun institusi yang secara aktif dan konkrit mewujudukan pengembangan ekosistem hidrogen tersebut

4.PLN ingin mendukung pemerintah dalam mencapai NZE 2060

5.Produksi Hidrogen bersih membutuhkan Listrik yang massif, sehingga PLN ingin mendorong pengembangan ekosistem hydrogen selain untuk dekarbonisasi tetapi juga untuk electricity demand creation. Misalnya 1 kg H2 membutuhkan 60 kWh, maka untuk produksi H2 sebesar 100 ktpa/ tahun, akan membutuhkan energi Listrik sebesar 6 TWh

INISIASI PLN DALAM PENGEMBANGAN EKOSISTEM HIDROGEN

1 IGNITION	2 CAMPAIGN & EDUCATION	3 PILOT PROJECT & JOINT STUDY
1. Produksi Green Hidrogen Pertama di Indonesia dari 1 lokasi (Pembangkit Muara Karang), memanfaatkan aset eksisting hydrogen plant (Excess Produksi) 2. Ekspansi Produksi/ Roll Out Green Hidrogen ke 22 lokasi lainnya	1. Produksi Green Hidrogen Pertama di Asia Tenggara dari Pembangkit Geothermal Kamojang 2. Pembangunan dan Pengoperasian Hidrogen Refueling Statio (HRS) 3. Pembangunan Hidrogen Center sebagai Knowledge Hub Hidrogen	1. *Pilot Project* uji coba Co-firing Hidrogen di PLTD/G Pesanggaran 2. *Pilot Project* produksi Green Amonia bekerjasama dengan PT Pupuk Kujang memanfaatkan fasilitas produksi Ammonia eksisting 3. *Pilot Project* uji coba Co-firing Green Ammonia di PLTU Labuan bersama IHI, memanfaatkan fasilitas pada butir ke-2 4. *Joint Study* Pengembangan Jakarta Hydrogen Mobility bersama EBTKE, Trans Jakarta dan Damri 5. *Joint Study* produksi H2 dengan Sembcorp dan ACWA

An innovative approach through existing equipment and facilities utilization has succeeded in presenting the #1 Green Hydrogen Plant in Indonesia

Existing electrolyzer united operated and then combine with innovative solution for Green Hydrogen Prdouction

Muara Karang CCPP, Jakarta

Overview

- Electrolyzer already operated since 2013
- Hydrogen for Generator Cooling system (own use)
- Electricity from Auxiliary of Muara Karang CCPP

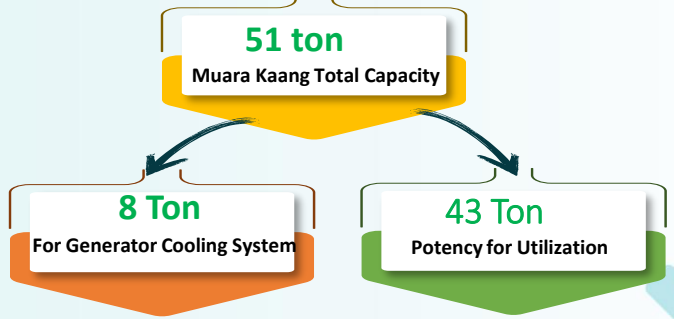
Captive power supply
PLTS Rooftop 413 kW

Innovative Solution for Green Electricity

Grid supply with RECs
2.077 MWh

Powering electrolyzer to produce Green Hydrogen

Directorate General of MEMR, CEO PLN & CEO PLN Nusantara Power attended the inauguration of 1st Green Hydrogen Plant in Muara Karang 9 Oktober 2023



Muara Karang GHP has annual potency of 43 ton of Green Hydrogen to be utilized

PLN strengthens its commitment as a leader and epicenter of hydrogen development with the operation of 21 Green Hydrogen Plants (GHP) on Nov 20th, 2023

Source

21 Power Plants

- **19** in Java
- **1** in Bali
- **1** in Sumatera

Total Capacity

Green Hydrogen | **199** tons/year

Utilization

For generator cooling	Excess production for hydrogen fuel
75 tons/year	**124** tons/year

Green Hydrogen Power Plant:
PLTP Kamojang, PLTU Pangkalan Susu, PLTU Suralaya 1-7, PLTU Suralaya 8, PLTGU Cilegon, PLTU Labuhan, PLTU Lontar, PLTU Pelabuhan Ratu, PLTGU Muara Tawar, PLTU Indramayu, PLTGU Tambak Lorok, PLTU Tanjung Jati B, PLTU Rembang, PLTU Tanjung Awar-awar, PLTGU Gresik, PLTG Pemaron, PLTU Paiton, PLTU Grati, PLTU Pacitan, dan PLTU Adipala

Completing the 21-power plant, PLN operated Kamojang Green Hydrogen Plant as #1st Green Hydrogen Plant in Geothermal Power Plant on 21 February 2024

Hydrogen Production to be utilized

Capacity	Location
128 ton/year	13 CFPP, 7 CCGT, 1 SGT, 1 GPP

With daily production capacity about **12 kg/day or 4.68 ton/year**, Kamojang GHP become the 1st dedicated Green Hydrogen Plant owned by PLN

PLN operates Indonesia's first Hydrogen Refueling Station (HRS) in Senayan on Feb 21st, 2024 to encourage and support the development of Hydrogen Mobility

Senayan Hydrogen Refuel Station has a charging station for hydrogen cars and a charging station for electric cars with electricity supplied from fuel cell hydrogen generators

Green Hydrogen Car Refueling Station

Green Hydrogen EV Car Charging Station

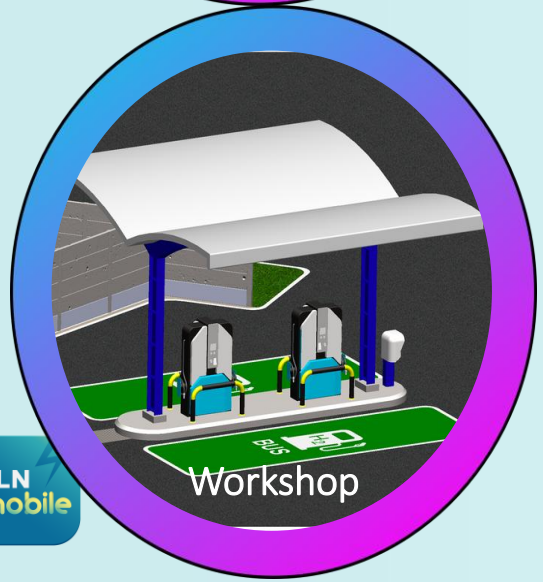
Danantara Indonesia

PLN

We develop the 1st Integrated Learning and Competency Centre in Senayan, incorporated with BRIN and IFHE


The Building


Discussion Room


Workshop


Practice Facility


Disscusion about Hydrogen


H2 Course by BRIN


Training by IFHE expert


Training for PLN staff

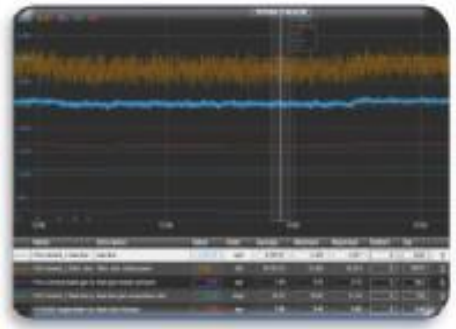
PLN mobile

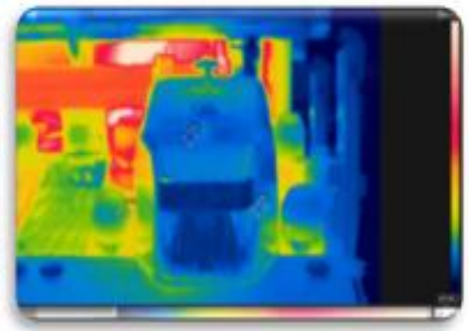
PLN melakukan Kerjasama *Pilot Project* dan *Joint Study* dengan berbagai Perusahaan Lokal maupun Global dalam mengembangkan ekosistem Hidrogen

Uji Coba Co-firing Hidrogen di PLTDG Pesanggaran

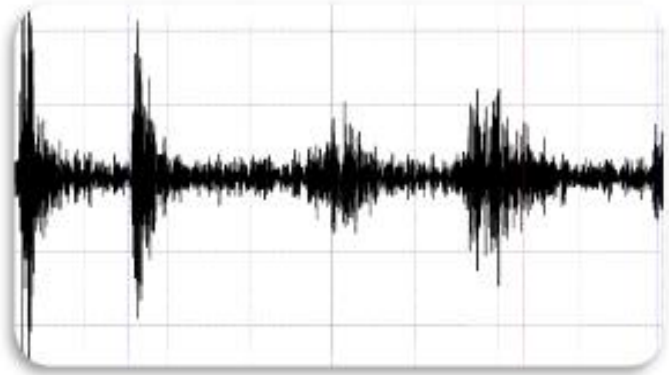
Pada tahun 2022, PLN IP di PLTDG Pesanggaran Bali Unit #2 (16 MW) berhasil menguji bahan bakar bebas karbon dengan menerapkan campuran hidrogen sebesar 2%vol dengan gas alam, dan meningkat menjadi 7%vol pada tahun 2024

Tidak terdapat kerusakan saat pelaksanaan uji





Parameter mesin normal & tidak terdapat knocking



Vibrasi normal

- Durasi uji: 4 jam
- H_2 29.4 kg/jam H2 untuk 7% co-firing
- Konsumsi LNG berkurang hingga 6.4%
- Tidak terdapat peningkatan emisi NOx, CO_2, atau SO_2.

Danantara Indonesia

Green Ammonia Production

- PT. Pupuk Kujang berhasil melakukan proses produksi *green ammonia* pertama di Indonesia.
- *Green Ammonia* ini bersumber dari *green hydrogen* yand diproduksi oleh ekses *Hydrogen Plant* PLN Indonesia Power.
- Sebanyak 1 ton *green hydrogen* dikonversi menjadi 5 ton *green ammonia*

Waktu Peresmian: **04 February 2025**
Location: PT. Pupuk Kujang (Cikampek)

Partnership:
- PLN dan PLN Indonesia Power
- Pupuk Indonesia dan Pupuk Kujang
- IHI Corp.

PLN mobile

Peresmian Proses Produksi Green Ammonia Pertama di Indonesia

Uji Coba Co-firing Ammonia PLTU Labuan
Kerjasama antara PLN, PT Pupuk Kujang, dan IHI Corporation

PLN Indonesia Power terus berinovasi dengan melakukan uji coba pembakaran campuran amonia sebesar 3% di PLTU Banten 2 Labuan Unit #2 (300 MW).

Pelaksanaan Uji Coba Co-Firing Amonia di PLTU Labuan 25-26 Februari 2025

Pengembangan *Jakarta Hydrogen Mobility*
Kerjasama antara PLN, EBTKE, Transjakarta dan DAMRI

Penandatanganan MoU Pengembangan Hydrogen Fuel Cell Mobility Ecosystem untuk Transportasi Bus di Indonesia

Pengembangan *Jambi Green Hydrogen Plant*
Kerjasama PLN dengan Sembcorp

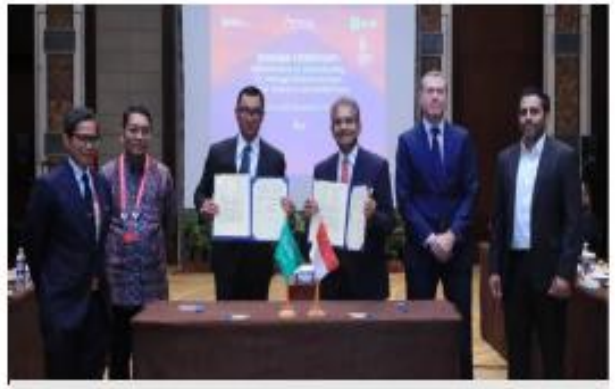
Memorandum of Understanding (MoU) Signing
PLN – Sembcorp
23 February 2023
regarding
"Business Cooperation Initiative in Support of Energy Transition Program"

Joint Development Study Agreement (JDSA) *Signing*
PLN – Sembcorp
24 October 2023
regarding
"The Development of A Green Hydrogen Plant dan Green Hydrogen Long Term Offtake"

Joint Development Agreement (JDA) *Signing*
PLN EPI – Sembcorp
21 October 2024
regarding
"The Development of A Green Hydrogen Plant dan Green Hydrogen Long Term Offtake"

Joint Development Framework Agreement (JDFA) Signing
PLN EPI – Sembcorp – TGI
3 November 2024
regarding
"Hydrogen Transportation Pipeline Connecting Sumatera, The Riau Islands and Singapore

Pengembangan *Green Hydrogen Plant* di Gresik
Kerjasama PLN, Pupuk Indonesia dan ACWA Power



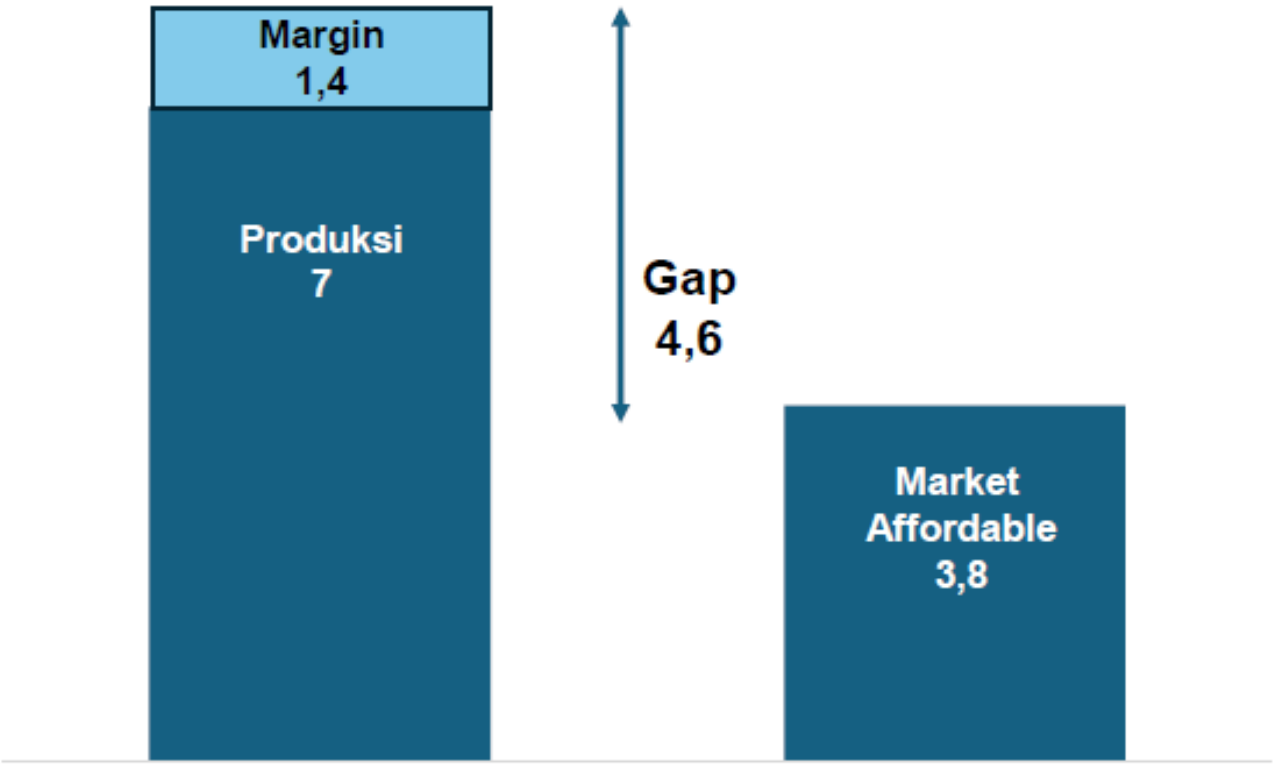
Memorandum of Understanding (MoU) Signing PLN – ACWA POWER di Event G20 Bali 24 November 2022 tentang Aliansi Strategis PLN – ACWA POWER

Joint Development Study Agreement (JDSA) *Signing* PLN – Pupuk Indonesia – ACWA Power di Kantor KBMUN 11 Juli 2023 tentang Pengembangan *Green Hydrogen* dan *Green Ammonia Terintegrasi*

Joint Development Agreement (JDA) *Signing* PLN – Pupuk Indonesia – ACWA Power di COP 28 Dubai 3 Desember 2023 tentang Rencana Membangun Hydrogen Plant di Gresik dan Green Ammonia di Pupuk Gresik Plant

Hasil Joint Study antara PLN, Pupuk Indonesia dan ACWA

TIDAK FEASIBLE



*) Dalam USD / kg

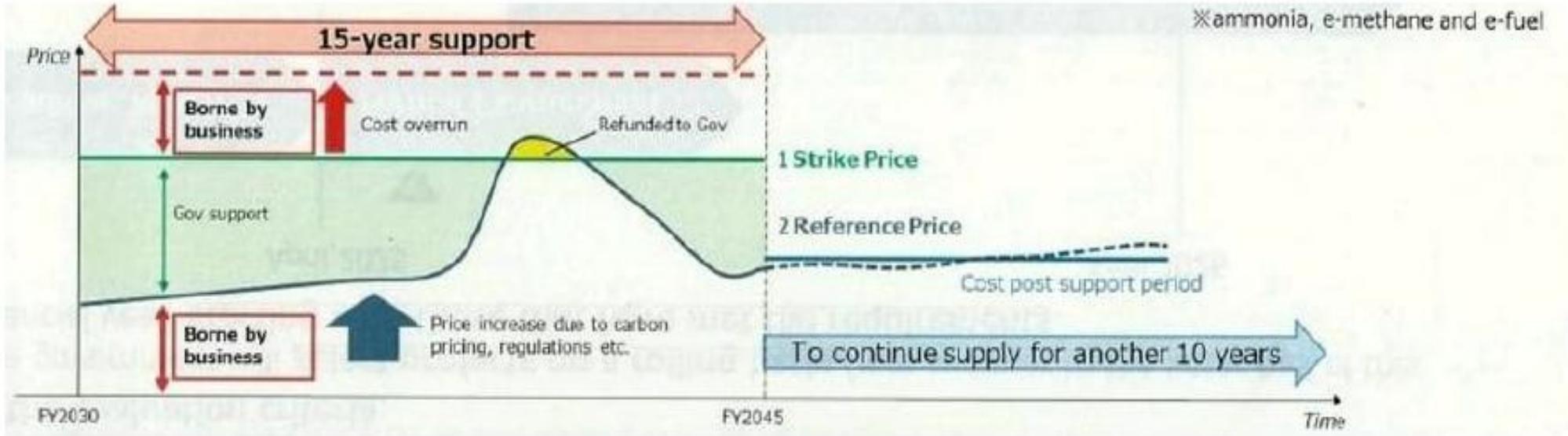
Benchmark Pengembangan Hidrogen di Global

Meski biaya produksi hidrogen (H_2) **saat ini masih melambung jauh di atas harga yang dapat diterima pasar**, namun demi mengakselerasi lahirnya *era energi bersih masa depan*, berbagai negara berlomba-lomba **menggelontorkan insentif** sebagai katalis agar hidrogen segera menjadi Leader transisi energi global."

" Expensive Hydrogen" is the largest bottleneck
in this early stage of Hydrogen Society around the world

Some countries (incl. Japan) recently introduced
supporting schemes for Hydrogen adoption

Insentif Pemerintah Jepang untuk mengakselerasi Produksi Hidrogen



1. Pemerintah Jepang menetapkan harga beli keekonomian H2 dalam USD/kg *(strike price)*
2. *Reference Price* adalah harga energi lain (LNG) yang akan di substitusi dengan H2 (*reference price* sudah dikonversi menjadi harga ekuivalen USD/kg H2
3. Pemerintah Jepang akan memberikan subsidi sebesar selisih antara strike price dan *reference price*, selama durasi 15 tahun masa *support* (2030-2045)

Various Option To Support Hydrogen Society

H_2 / NH_3 Supporting Options

Produce	Carry & Store								Consume
Supply Chain	Produ-ction	conver-sion	Trans-port	Storage	Trans-port	accept	Storage	Conver-sion	Trans-port	Storage	Use

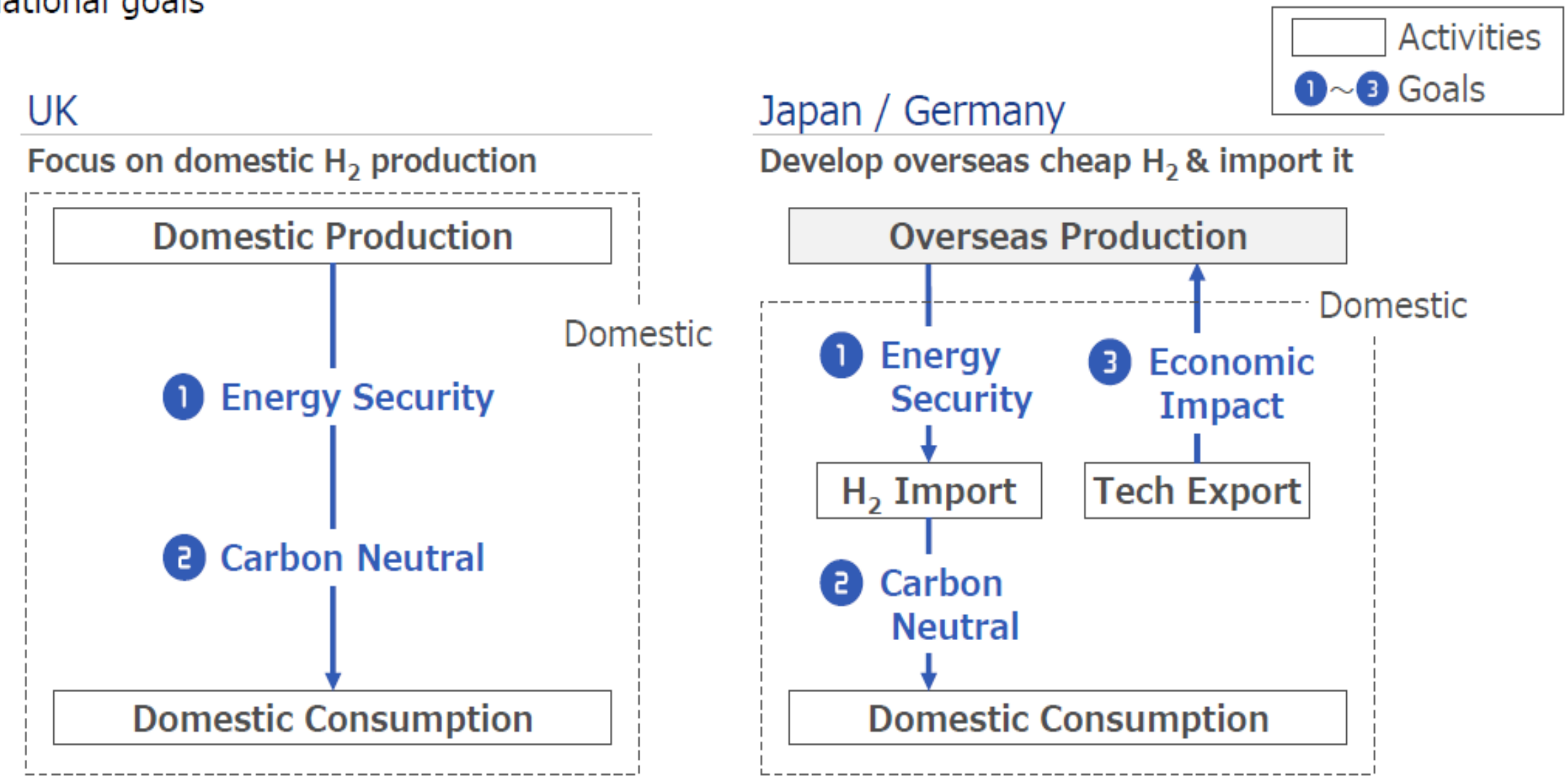
Upstream — Middle — Down-stream

		Upstream	Middle	Down-stream
Direct	CAPEX	**Subsidy for renewables / electrolyzers** • NZHF* (UK)	**Subsidy for H_2-receiving Infrastructure Dev.** • Port / Pipeline / …	**Subsidy for Use cases** • Asset Renovation • FCV Discount
	OPEX	**Price Gap Compensation** • H2Global (Germany), HBM* (UK), H_2 bank (EU), …	N/A	N/A
Indirect		**Tax Deduction** • IRA* (US)	N/A	**Carbon pricing** • ETS / Cap & Trade

- NZHF: Net Zero Hydrogen Fund,
- HBM: Hydrogen Business Model,
- IRA: Inflation Reduction Act
- FCV: Fuel Cell Vehicle
- ETS: Emission Trading Scheme

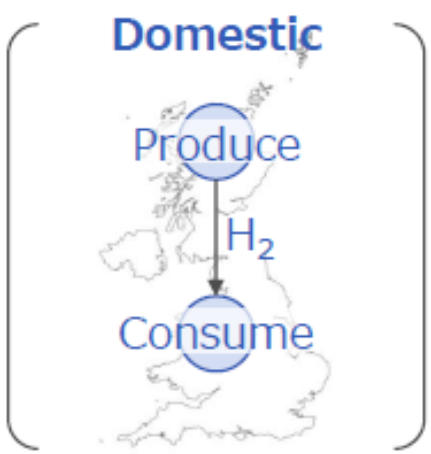
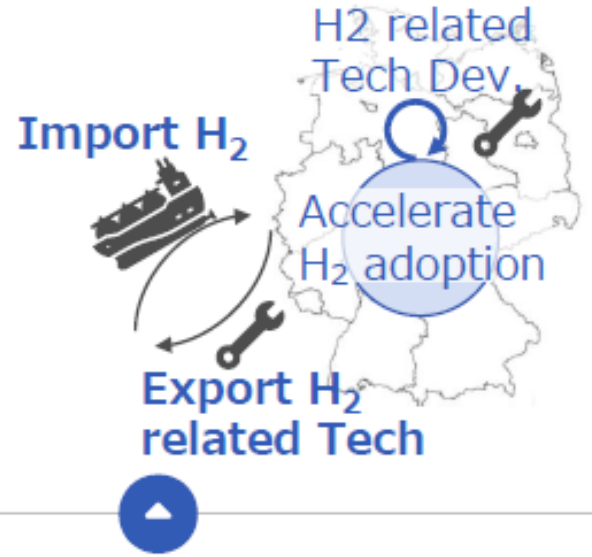
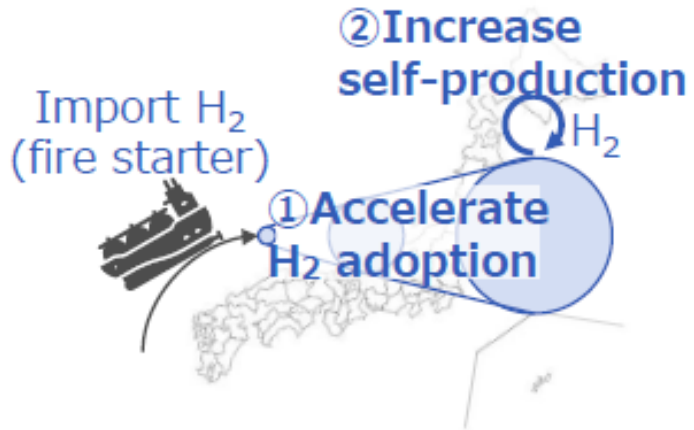
National Goals And How To Achieve Them Vary By Countries

National goals



Benchmark Of Other Countries' Policy Direction For Hydrogen

Details of each country

		Self-Produce & Consume	Import H_2 & Export Technology	
		UK	GERMANY	JAPAN
Policy Direction for Hydrogen				
Background	Carbon Neutral	**Targeted by 2050** • 78% cut (1990→2035)	**Targeted by 2050** • 55% cut (1990→2030)	**Targeted by 2060** • 46% cut (2013→2030)
	Energy Security	**Recently Drop in energy self-sufficiency**	**Mostly depends on one country for long term**	**Depends on fossil fuels import**
	Economic Impact	**Plans 100k+ Job Creation** • Published 10-Point Plan	**Supports H2-related techs** • Foreseeing H_2 society	**Include H_2 in key sectors in "Green Growth Strategy"**

UK Targets Domestic Production ⇔ Germany Aiming At Importing

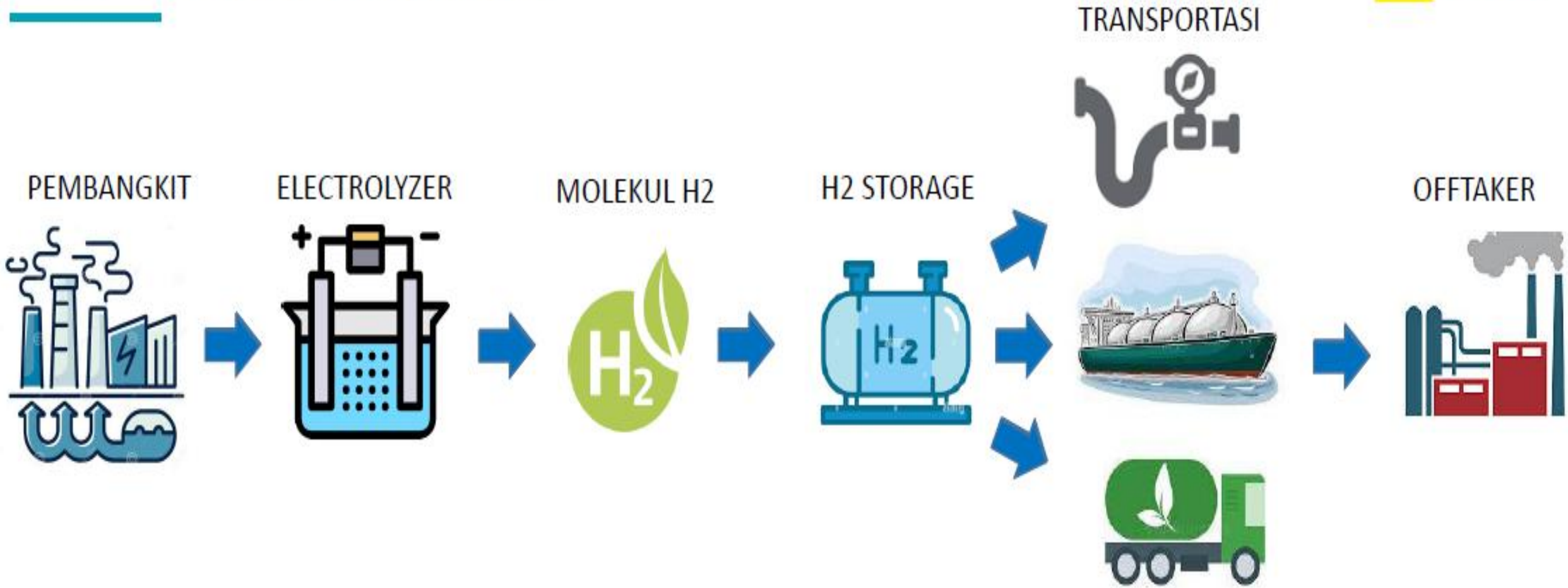
Conditions for Hydrogen Support

		UK	Germany	(Reference) Japan
Operating Entity		UK Low Carbon Contracts Company	HINIT.CO	JOGMEC
First Adoption		December 2023	December 2022	March 2025 (scheduled)
Target Product		**Hydrogen only**	**Hydrogen and E-fuels**	**Hydrogen and multiple derivatives**
Supply Side	**Production**	**Domestic produced Green & Blue H2**	**Imported Green H_2 derivatives**	**Domestic & Imported Green & Blue**
	Transportation	Pipeline / Tanker truck	Receiving in Gov-assigned ports	Both maritime & land transportation
	Quality	Applies "CertifHy Standard"	Currently not clarified	Building Carbon Intensity Standard
Deal System	**Dealing Method**	**CfD (Contract for Difference)**	**Double-side Auction**	**Subsidy for price gap**
	Tariff Price	LNG & other fossil fuels	Prepare targets for each application	Prepare calculation logics
Demand Side		Build Industrial H2 cluster	Around ports & City use	Focus on "Hard-to-Abate" sectors

* Japan Organization for Metals and Energy Security

Value Chain Bisnis Hydrogen

PLN



Hydrogen FCGH of Demonstration 25 February 2025

Key Deliverable

1. First H2-based power plant in Indonesia
2. Breakthrough for Environmentally Friendly Energy
3. Access to serve waiting list customer
4. Access to support economic growth

- 1st Phase HFCG operation done from 11 – 19 March 2025
- FCGH continuously to operate serve the load without interruption
- 6 cradles contain 75 kg H2 produce total electricity 1040.3 kWh with exported energy 995.9 kWh (losses energy 44,4 kWh or 4.3%) at minimum pressure 24 bar

Attendances:

PLN HEAD OFFICE

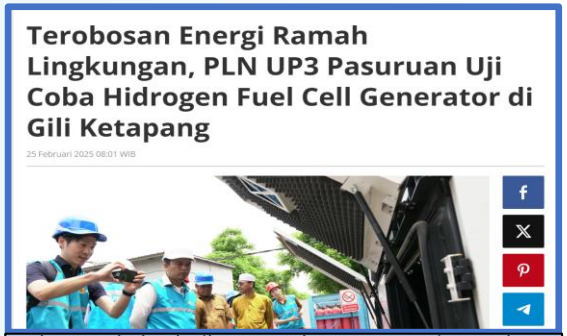
PLN UID JATIM

PLN Nusantara Power

PLN Suku Cadang

JICA

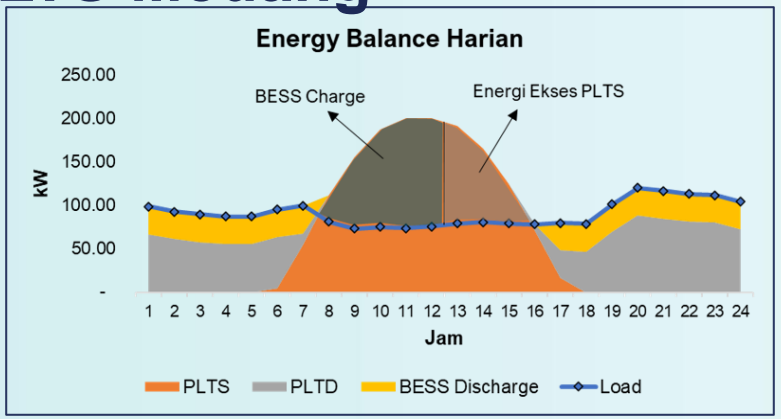
https://kabarbisnis.com/read/28128687/pertama-di-indonesia-pln-uji-coba-operasikan-pembangkit-listrik-tenaga-gas-hydrogen



https://kabarbaik.co/terobosan-energi-ramah-lingkungan-pln-up3-pasuruan-uji-coba-hidrogen-fuel-cell-generator-di-gili-ketapang/

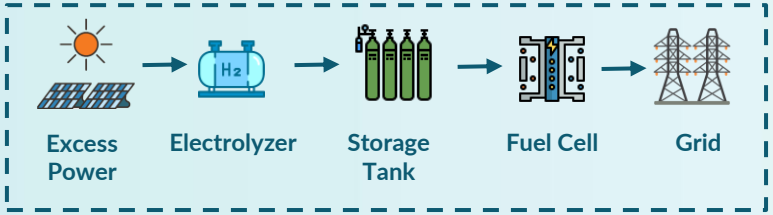
https://rri.co.id/surabaya/bisnis/1348031/pln-uji-coba-pembangkit-listrik-tenaga-gas-hidrogen

The project of Hydrogenation of Medang Island : harnessing hydrogen from excess capacity of PLTS Medang



Hydrogen systems have the potential to generate electricity at a more competitive cost (Rp 3,931/kWh) compared to diesel power plants (BPP for Medang Island's diesel power plant is 4,520 Rp/kWh)

Medang Island, located in West Nusa Tenggara, is a remote area with the potential for excess solar PV (PLTS) production of approximately ±400 kWh/day that remains underutilized.



Excess Solar PV = ± 400 kWh
*during peak production 6 hours

Excess per hour =
400 / 6 = 66.67 kW

Number of electrolysers needed:
66.67 kW / 2.4 kW = 28 units

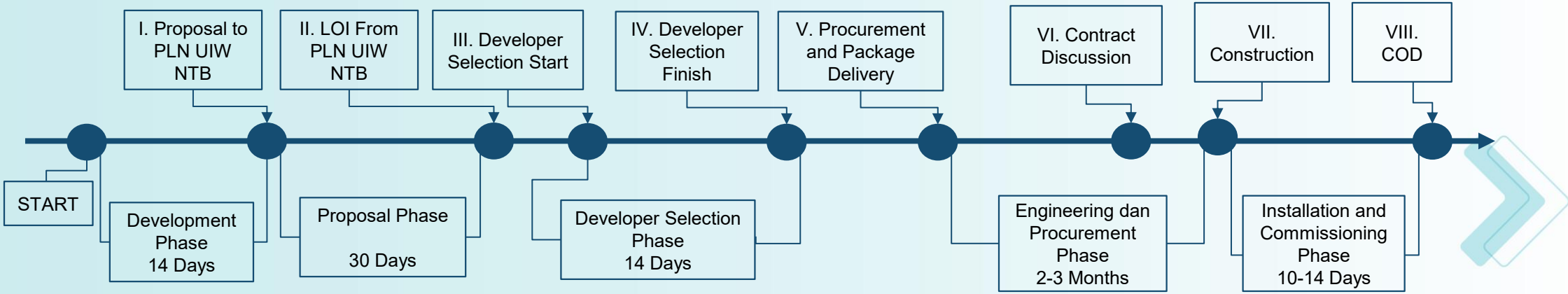
Heating Value of Electrolyser:
4.8 kWh/Nm³ or 53.39 kWh/kg

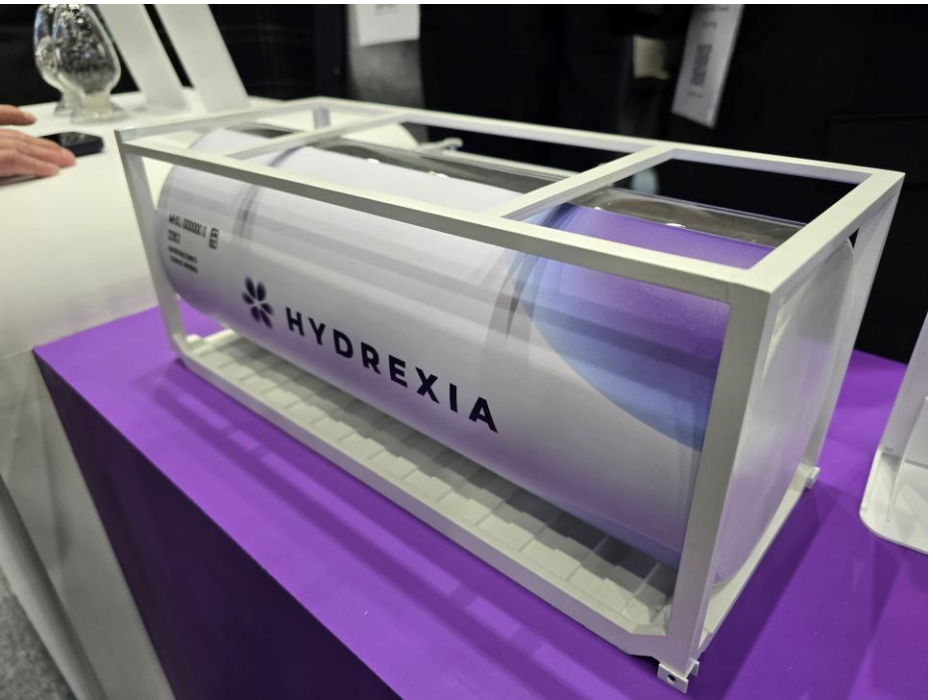
Daily H_2 Production:
400 kWh / 53.39 kWh/kg = ±7.5 kg

Fuel Cell Consumption:
70 grams/kWh or 14.29 kWh/kg

Daily H_2 Fuel : 7.5 kg

The electricity that can be generated is:
14.29 kWh/kg × 7.5 kg = ±107.18 kWh





METAL HYDRIDE


CHIYODA
CORPORATION
Mitsubishi
Corporation
NANYANG
TECHNOLOGICAL
UNIVERSITY
SINGAPORE
PSA
SPERA HYDROGEN

MCH-SPERA


GC-3
SHIMADZU

HYDRILITE

Lesson Learned Kebutuhan Dukungan Pemerintah

1. Akselerasi pengembangan hidrogen memerlukan intervensi dukungan pemerintah. Saat ini tidak ada satupun negara di dunia yang mampu memproduksi hidrogen di bawah harga yang dapat diterima oleh pasar

2. Model insentif Jepang dapat menjadi referensi Indonesia untuk mengakselerasi pengembangan hidrogen:
   a. Pemerintah melakukan lelang produksi hidrogen … ton/tahun untuk durasi 15 tahun sesuai *real* kebutuhan dalam negeri (memastikan matching antara produksi dan konsumsi domestik)
   b. Pemenang lelang adalah:
      - *Bidder* yang menawarkan *price gap* yang paling kecil (price gap adalah selisih antara harga jual dengan BPP, dimana harga jual sudah ditetapkan oleh Pemerintah);
      - *Bidder* mempunyai kewajiban membangun pabrik electrolyzer di Indonesia, sehingga produksi hidrogen mulai tahun ke-5 dihasilkan dari electrolyzer yang diproduksi di dalam negeri.

3. PLN siap melanjutkan dukungan kepada EBTKE untuk pengembangan ekosistem hidrogen.

Danantara Indonesia

PLN

Terima kasih

PLN mobile

www.pln.co.id