KOREA POWER EXCHANGE

Korea's Clean Hydrogen Power Generation Bidding Market

Subtitle : How to Ensure the Stability of the Hydrogen Supply

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smart KPX
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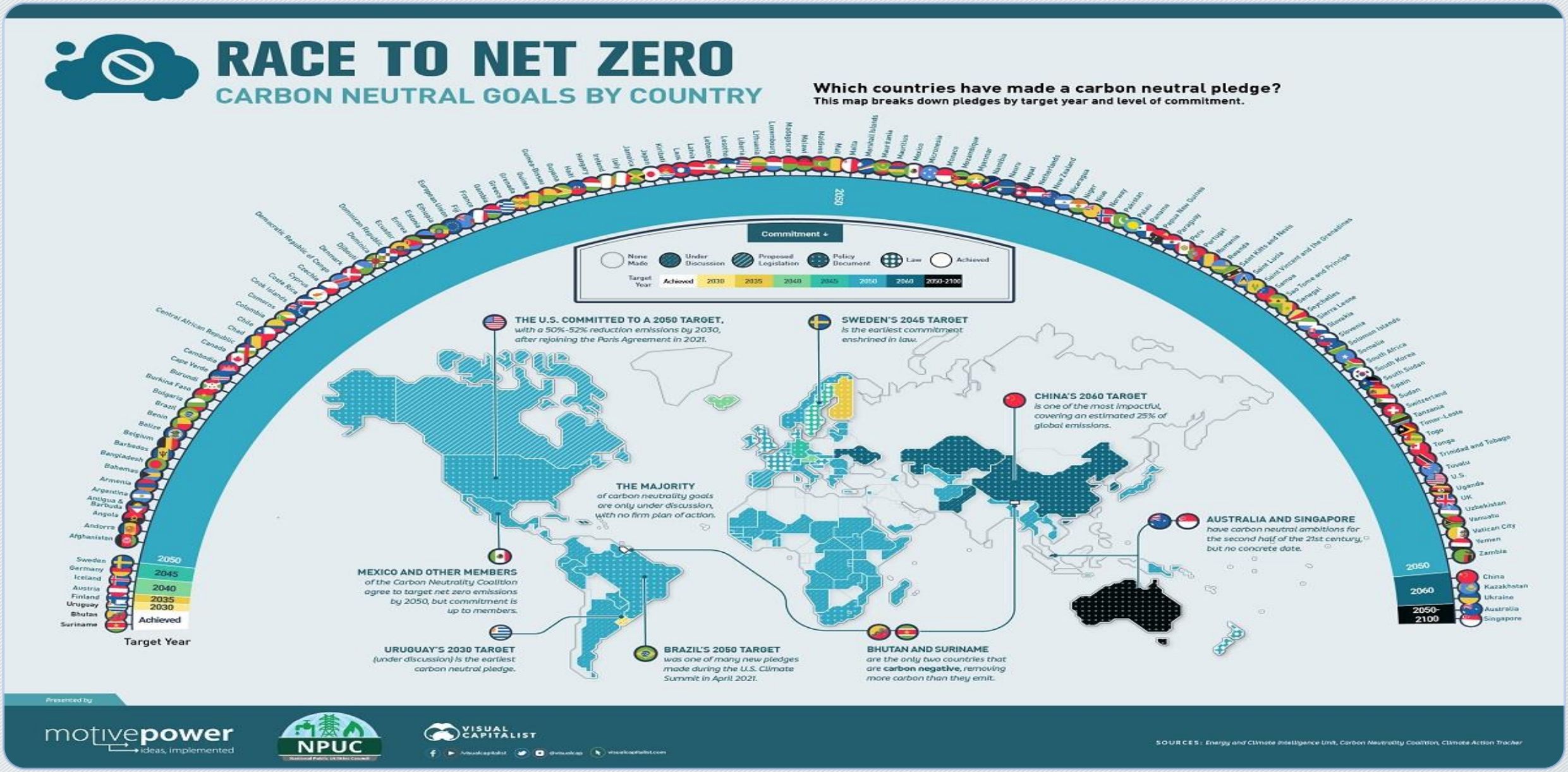


1 Significance of Clean Hydrogen Power Generation

Carbon Neutral — Contribution to Greenhouse Gas Reduction

- Electricity Generation using Clean Hydrogen as Fuel → One of the "Carbon-Free Energy" such as nuclear and renewable

Forecast for the proportion of power generation in the 10th Basic Plan for Long-term Electricity Supply and Demand

Category		Nuclear	Coal	LNG	Renewable	Hydrogen	Others	Total
2030	Electricity(TWh)	201.7	122.5	142.4	134.1	13.0	8.1	621.8
	Share(%)	32.4	19.7	22.9	21.6	2.1	1.3	100.0

Legacy — Preventing Thermal Power Plants from becoming Stranded Assets

- Existing Coal/LNG Power Facilities(62.6% in 2022) can be Converted to Hydrogen Power Generators without Major Changes

⇨ Equipment Investment can be minimized by Utilizing already established Transmission Networks or Replacing Combustors

Hydrogen Economy — Calling Water for Creating a Clean Hydrogen Ecosystem

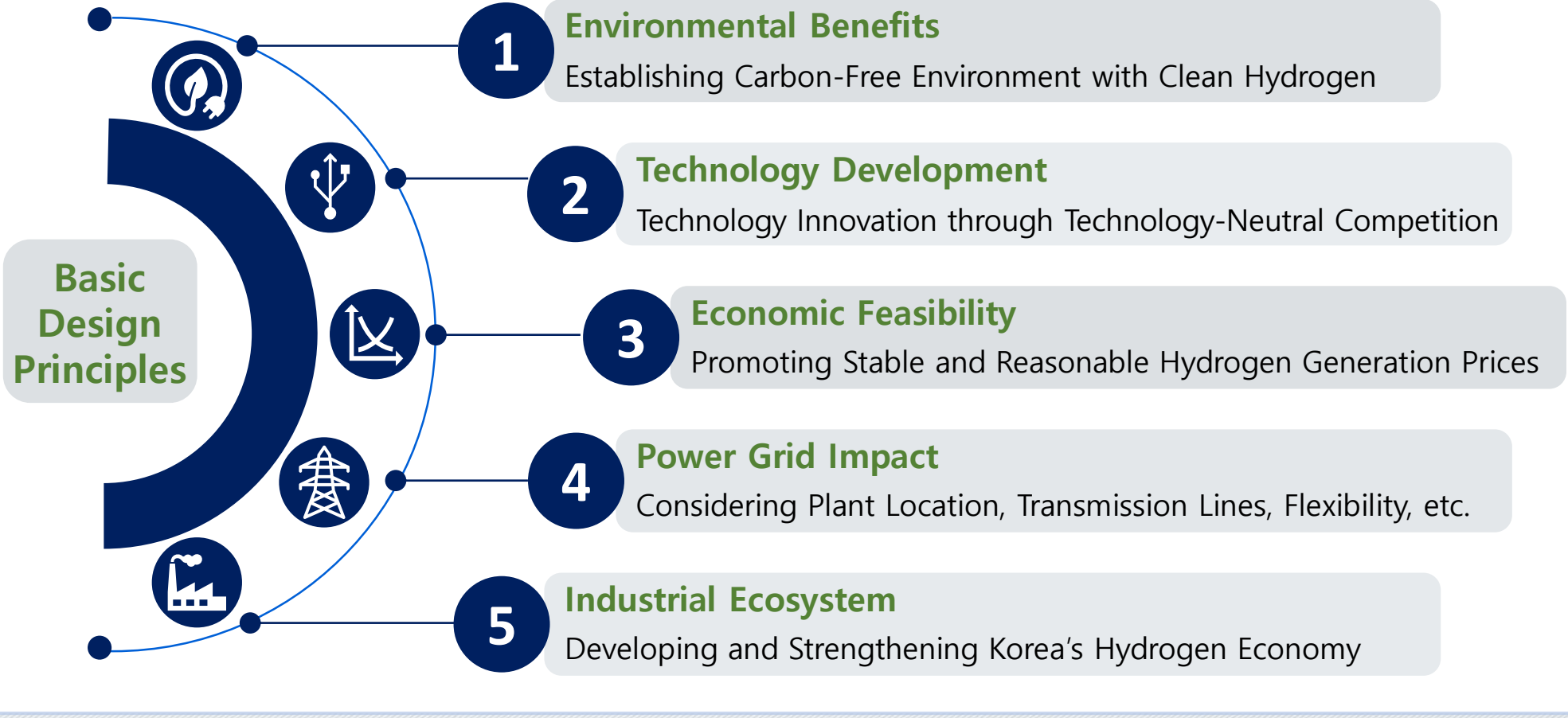
- The Use of Clean Hydrogen at the Power Plant level can Create Large-scale Demand for Clean Hydrogen

⇨ Possible to Promote Related Industries, Technology Development and Clean Hydrogen Ecosystem

* (Demand) Hydrogen Power Generation → (Distribution) Terminals, Storage Tanks, Pipelines + (Production) Domestic and Overseas Plants

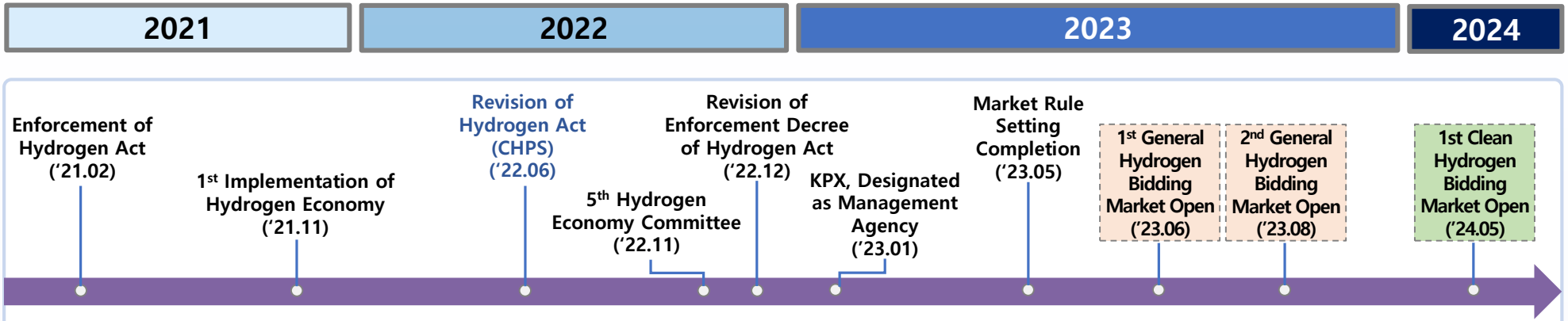
2 Korea's Hydrogen Power Generation Bidding Market Progress

Basic Design Principles In order to Achieve the Purpose of the Hydrogen Act, the Bidding Market Comprehensively Considers 5 Factors: Environment, Technology, Economics, Power Grid, Industry



2 Korea's Hydrogen Power Generation Bidding Market Progress

Hydrogen Generation Bidding Market



Establishing Bidding Market (MOTIE)

Hydrogen Act Article 25-6

The Minister of Trade, Industry and Energy may **establish a bidding market for hydrogen power generation** to facilitate the implementation the hydrogen economy.

Market Management Agency (KPX)

Hydrogen Act Article 25-7

To efficiently operate a bidding market, the Minister of Trade, Industry and Energy may **designate an institution, and organization, or a corporation** related to hydrogen business or electricity transactions that meets the standards prescribed by Presidential Decree, such as facilities and human resources, as an agency managing a bidding market.

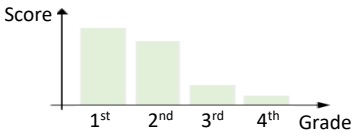
3 Clean Hydrogen Power Generation Bidding Market Design

Market Design Factors		Detailed Operating Policy
1 Basic Factors	Opening Volume	6,500GWh (2024 market)
	Contract Period	Preparation 3yr + Generation 15yr * Coal fired plants are limited to its remaining lifespan
2 Bidding Mechanism	Bidding Volume	Annual Hydrogen Power Generation (kWh)
	Bidding Price	Total LCOE (Fixed Costs + Fuel Costs)
	Price Ceiling	LCOE and Indexing Fuel Costs (not disclosed)
3 Select Award Winners	Requirements	Credit Rating, Flexibility, Remaining Lifetime, etc.
	Evaluation	Price factor(60%) + Non-price factor(40%)
4 Real-time Market Linkage and Settlement	Real-time Operation	Central Dispatch Power Plant
	Spot Settlement	System Marginal Price
	Settlement for Hydrogen Generation	Pay as Bid
		Contract for Difference (LCOE - SMP)
		Indexation for Fuel Price Changes(only for Blue H_2)
	Penalty	Insufficient Generation, Delays in Operation, etc. Insufficient Power Generation → No Settlement Delays in Commercial Operation → Reduction of Contract Period

Evaluation Standard

Price (60%)	Lowest Price	• Total LCOE (Fixed Costs + Fuel Costs) • **[(Lowest Price / Bidder's Price) × 60]**
Non-price (40%)	Quantitative & Qualitative Evaluation	• **[Total Score × 0.4]** • Focused Evaluation of Clean Hydrogen Grade, Industrial Economic Contribution, and Stability of Fuel Supply

Key Factors

Evaluation Factors		Evaluation Metrics
Environmental Contribution	GHG Emission Factor	• GHG Emissions per unit power generation GHG Emission Factor=(1-cofiring rate) × Benchmark Score = Assigned Points × (1-GHG Emission Factor)
	Clean Hydrogen Grade	• The Grade of Clean Hydrogen Certification Grade: 1st / 2nd / 3~4 Score: 100% / 90% / Below 50% 
Industry & Business Contribution		• Contribution to Domestic Industry or Job Creation Effect of Infrastructure Facilities, Equipment, etc. • Establishing Hydrogen Value Chain and Industry
Business Confidence	Stability of Fuel Import	• Participation Rate in Fuel Production by Domestic Companies • Procurement Plan, Contract Progress, Business Reliability, etc.

※ In addition, Evaluation of Resident Acceptance, Credit Rating, System Acceptance, etc.

3 Clean Hydrogen Power Generation Bidding Market Design

Design Concepts

General H_2 Economics, Power Grid, Industry Clean H_2 Environment, Economics, Industry

Category	Environmental Benefits	Economic Feasibility	Power Grid Impact	Industrial Ecosystem
General Hydrogen Market	○	◎	◎	◎
Clean Hydrogen Market	◎	◎	○	◎

- (Environmental Benefits)
  - H_2 Grade with Lower CO_2 Emissions
  - Degree of Reduction in GHG Emissions
- (Economic Feasibility)
  - Affordable Price for Consumers
  - Low Volatility Fuel Costs

- (Industrial Ecosystem)
  - Infrastructures for Hydrogen Power Plants
  - Stability of Fuel Supply

Category	Environmental Benefits	Economic Feasibility	Industrial Ecosystem
Price Evaluation	-	• Total LCOE • Fuel Costs Indexing	-
Non-price Evaluation	• Clean Hydrogen Grade • GHG Emission Factor • Ceiling for Utilization Rate	• Low Variation Costs Portion (Variation costs per LCOE)	• Industry & Business Contribution • Stability of Fuel Supply

Securing of Clean Hydrogen for Power Generation is an Important Factor in Overall Price/Non-price Evaluation

4 How to Ensure the Stability of the Hydrogen Supply

Need to Explore Implications by Reviewing cases of LNG import because of the Similarity of Clean Hydrogen and LNG

- **(Project Based)** Need to establish all stages of the value chain spanning fuel Development-Production-Liquefaction-Transportation-Storage-Consumption

- **(Production Region)** Blue Hydrogen Projects are active Mainly in Existing LNG Production Areas

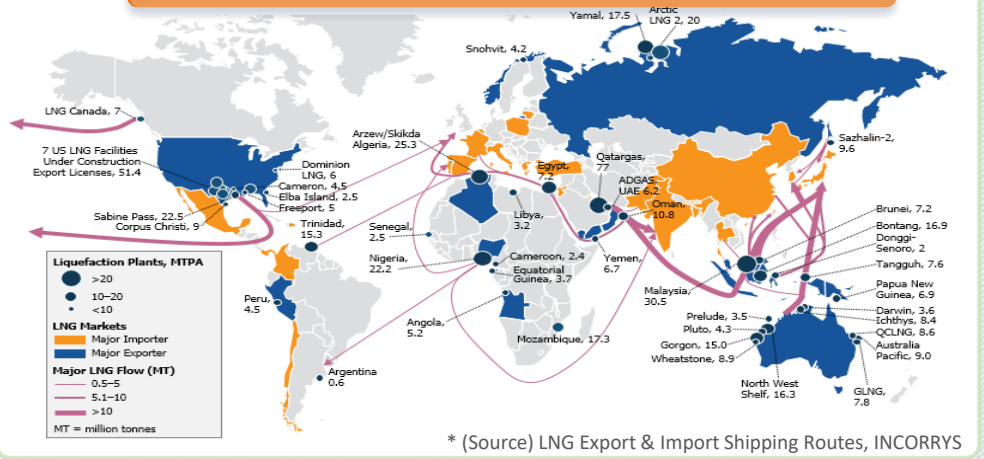
  * Green Hydrogen is also being developed on a Large Scale in countries with Good Renewable Energy Conditions

- **(Pricing Formula)** Link to a Index to Mitigate Risk due to the Nature of Long-term Contracts

It is very Important to Develop Economically viable Clean Hydrogen and Ensure its Stable Supply

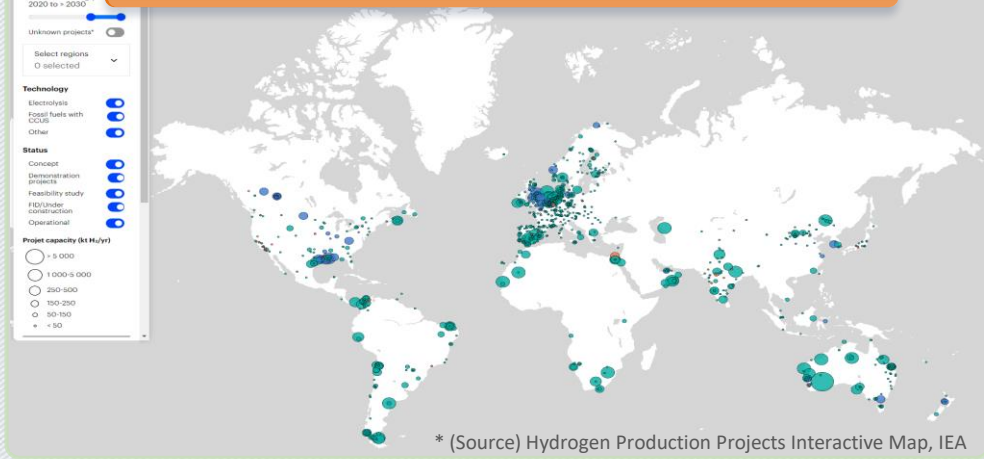
☞ **Need for a Close Review of LNG Import cases, including the Trends and Contract System of the LNG market**

Global LNG Production; Export & Import Status



* (Source) LNG Export & Import Shipping Routes, INCORRYS

Current Status of Global Clean Hydrogen Projects



* (Source) Hydrogen Production Projects Interactive Map, IEA

4 How to Ensure the Stability of the Hydrogen Supply

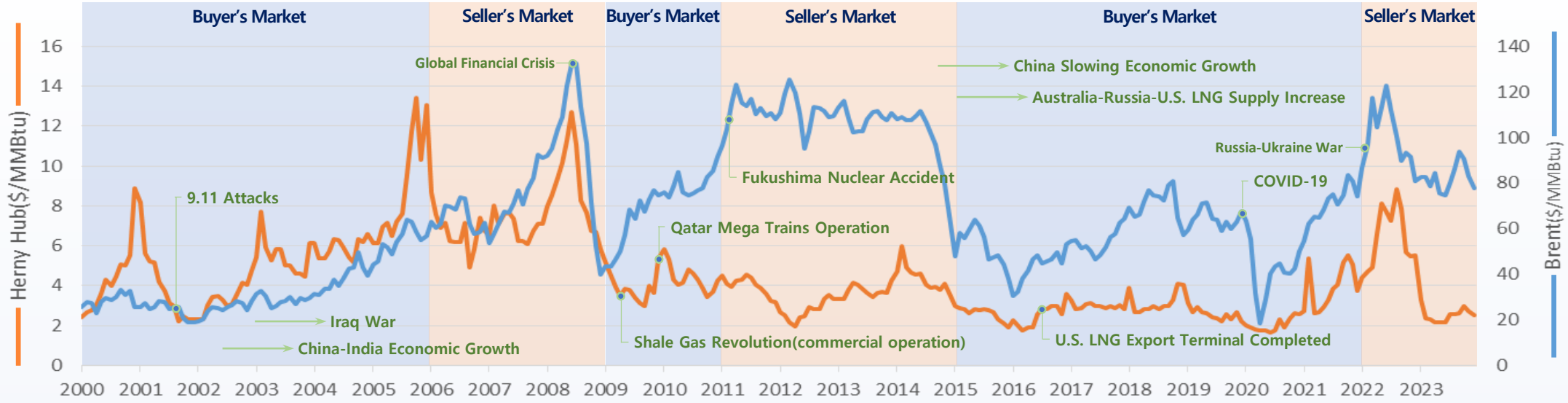
LNG Case Review — Characteristics of the Natural Gas Market and Yearly Change Trends

- **(Market Properties)** Capital Intensity, Long-term Contract Basis, Insufficient Liquidity, Regional Division, Linked Pricing System

Comparison of Market Characteristics: Oil vs. LNG

Market	Import Countries	World Trading Vol.	No. of Vessels	Contract Type	Trading Costs	Pricing Method
Oil	Most countries	3,376 Mtoe	11,613	3~5 years (40~60%)	Low	International Market Price
LNG	45 countries	468 MToe	689	15~25 years (60~80%)	High	Oil/Gas Price Linkage

- **(Price Changes)** Periodic Fluctuations in the Global LNG market occur as shocks on the Demand side add to Supply capacity



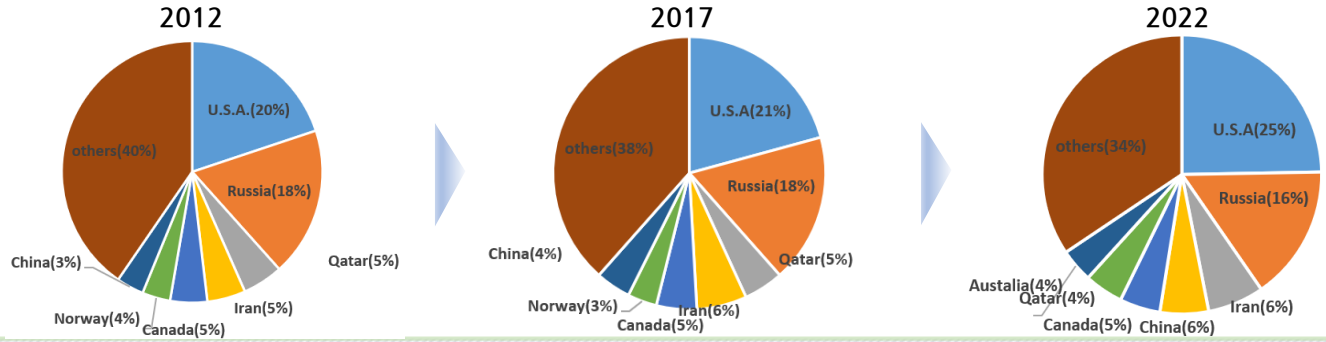
4 How to Ensure the Stability of the Hydrogen Supply

LNG Case Review — Natural Gas Production and Export / Import Countries Status

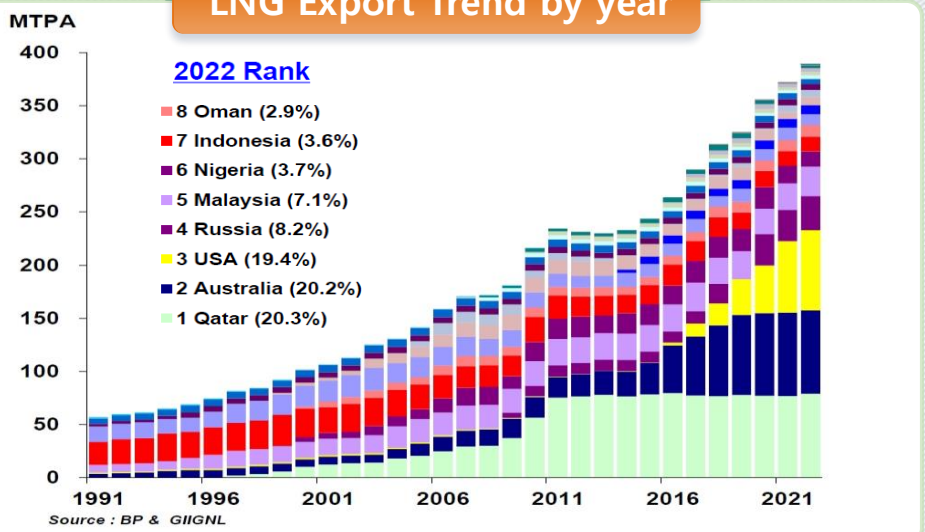
- The Shift from the Middle East to the U.S. as the Hub of Natural Gas Production due to the Shale Gas Revolution

Natural Gas Production Share

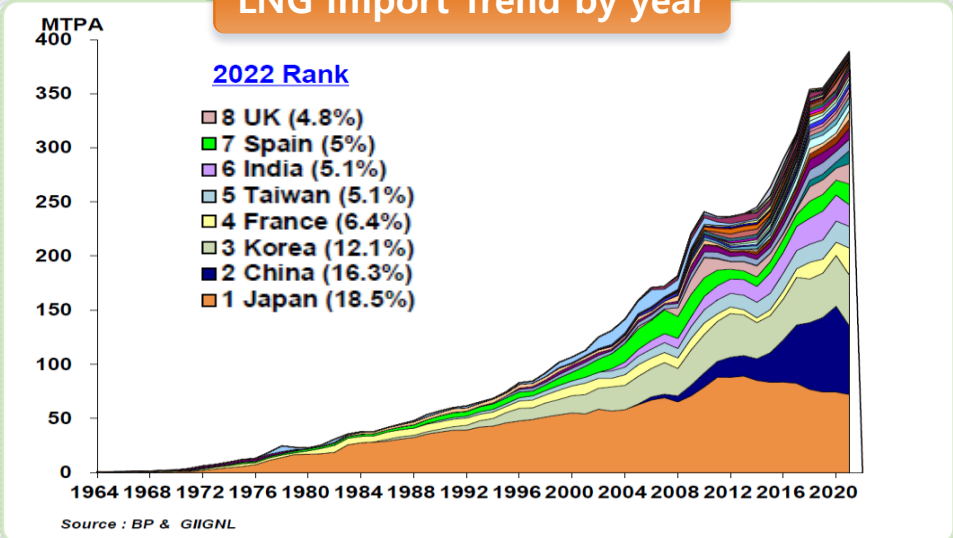
Source : KOSIS



LNG Export Trend by year



LNG Import Trend by year



4 How to Ensure the Stability of the Hydrogen Supply

LNG Case Review — Changes in Pricing Method and Contract Flexibility

- **(Increase in Gas Price Linked Contracts)** Henry-Hub Linked Contracts have emerged as the Mainstream from the Oil Price Linked ones

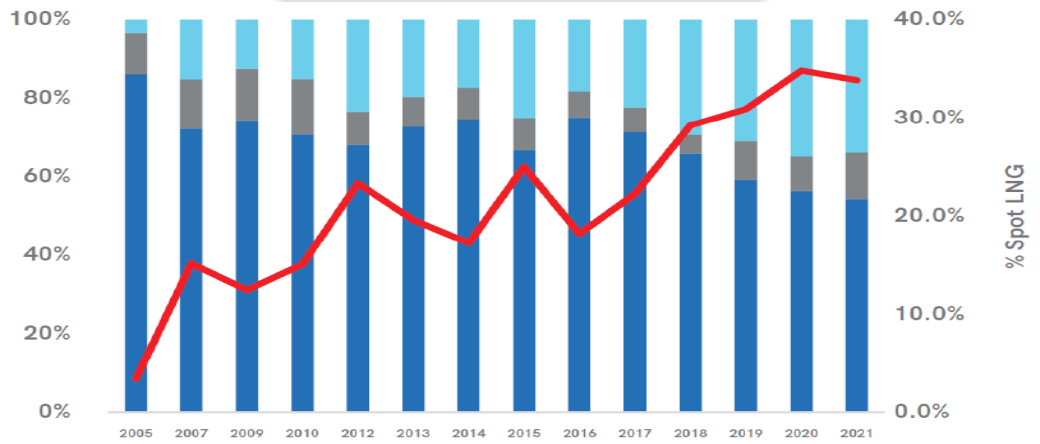
  * LNG Contract Type by Region : (Asia) Linked to Oil price , (North America) Linked to Gas Hub price (HH, etc.) , (Europe) Mixed – Linked to Oil price or Gas Hub price

- **(Relaxation of Destination Designation)** Rigid Transport Conditions are Improving due to the EU Commission's and the JFTC's recommendation

Survey on LNG Trades of Japan Fair Trade Commission('17)

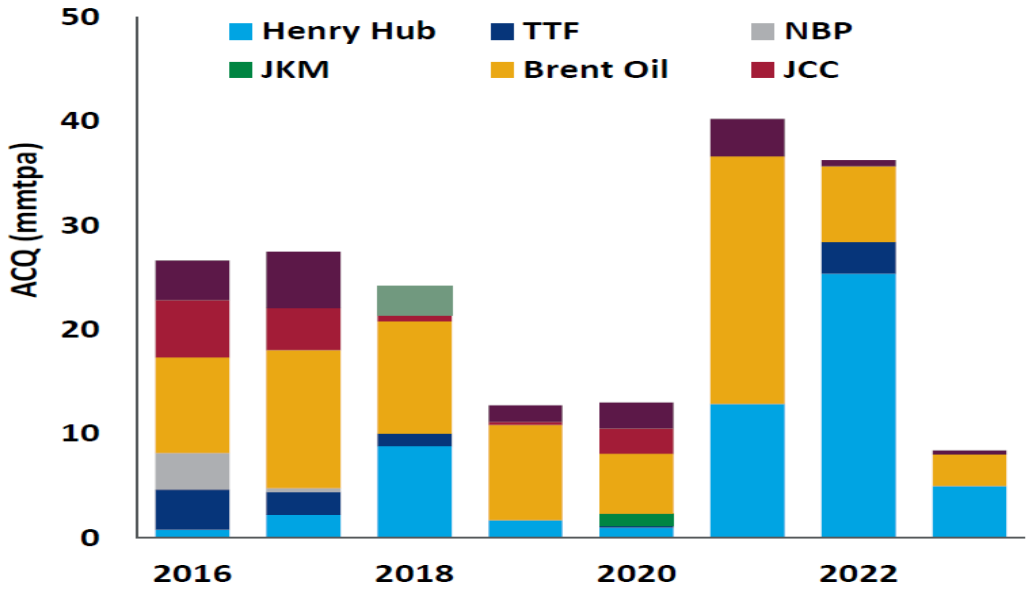
- LNG sellers should neither provide competition-restraining clauses nor adopt competition-restraining business practices for the new FOB contracts

LNG Contract Trends (1)



* OPE; Oil Price Escalation, GOG; Gas-on-Gas Competition

LNG Contract Trends (2)



Source : Wood Mackenzie, "LNG contract trends," May 2023

4 How to Ensure the Stability of the Hydrogen Supply

LNG Case Review — 15th Basic Plan for Long-term Natural Gas Supply and Demand

❶ Stability of Fuel Supply; Energy Security

- **(Diversification of Supply Lines)** Enhancing the Stability of Fuel Supply even when Supply is Disrupted in a Specific Region

Proportion of LNG Import by country (unit: %)

year	1st	2nd	3rd	4th	5th
2012	Qatar (28.9)	Indonesia (20.8)	Oman (11.4)	Malaysia (11.2)	Russia (5.8)
2017	Qatar (31.2)	Australia (18.3)	Oman (11.4)	Russia (5.3)	USA (5.2)
2022	Australia (25.1)	Qatar (21.0)	USA (12.4)	Malaysia (11.9)	Oman (10.2)

- **(Diversification of Portfolio)** Various Composition with Long-term/Mid-term/Short-term/Spot Contracts
- **(Strengthening Cooperation)** Information Exchange, Joint Purchasing and Securing Overseas Equity with China and Japan

❷ Stability of Contract Price; Import Economic LNG

- **(Cooperation between Public and Private Sectors)** Enhancing Negotiation Power, including Fuel Price Reduction
- **(Diversification of Price Index)** Diversification of Spot Contract Price Index centered on Natural Gas Price Index

4 How to Ensure the Stability of the Hydrogen Supply

Design Direction — Focus on the Stability of Fuel Supply and Electricity Price

❶ Measures to Secure Supply Stability

- (Investment in Equity) Securing a Stable Supply of Clean Hydrogen through Equity Investment rather than Off-take
- (Supply Portfolio) Preparing for Localized Disputes and Disruptions to some Production Facilities
- (Degree of Business Plan's Completion) Differential points allocated by Clean Hydrogen Development Project Progress

H_2 Business Procedure(ex.)	Secure Plant Site	Pre F/S	F/S	Pre FEED	FEED	FID	Construction & Production

- (Degree of Fuel Contract's Completion) Differential points allocated by Clean Hydrogen Fuel Contract Level

Fuel Contract Procedure(ex.)	LOI (Letter of Intent)	MOU (Memorandum of Understanding)	HOA (Heads of Agreement)	Conditional Contract based on winning	SPA (Sales & Purchase Agreement)

- (Flexibility on Contract Terms) Contract Conditions for Destination Clauses, Take or Pay, DQT/UQT, etc.

❷ Measures to Secure Price Stability

- (Low Variable Costs Ratio) Preference given to Fixed price contract compared to Variable price contract
- (Ceiling for Fuel Costs Indexation) Prevent Excessive Fuel Cost Compensation by Limiting the Index Application Slope

4 How to Ensure the Stability of the Hydrogen Supply

Evaluating Factors — Setting Various Items to Ensure the Stability of Fuel Supply and Electricity Price

Design Direction		Evaluation Factors		Evaluation Metrics
Measures to Secure Supply Stability	Investment in Equity	Energy Security		▪ Differential points allocated by Direct Development/Equity Investment/Off-take
	Supply Portfolio	Fuel procurement reliability	Diversification of Portfolio	▪ Evaluation of improving the stability of clean hydrogen supply in preparation for local disputes and disruption of some production facilities
	Degree of Business Plan's Completion		Supply Project Progress Level	▪ Differential points allocated by Clean Hydrogen Development Project Progress
	Degree of Fuel Contract's Completion		Fuel Purchase Contract Level	▪ Differential points allocated by Clean Hydrogen Fuel Contract Level
	Business Conditions Reliability		Supply Project Reliability	▪ Analysis of fuel development project credit rating, fuel introduction risk factors and evaluation of response measures, etc.
	Flexibility on Contract Terms		Detailed Terms and Conditions	▪ Review of ensuring flexibility in contract terms for Destination Clauses, Take or Pay, DQT/UQT, etc.
Measures to Secure Price Stability			Low Variable Costs Ratio	▪ Proportion of fixed price contract amount among total LCOE
		Price Ceiling	Ceiling for Fuel Costs Indexation	▪ Setting the Upper Price Limit for variable prices subject to index application

Thank You

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