九州大学講義　2020年1月16日

Thinktank Roundtable A (IEEJ)　SIEW2018より

Energy Transition

Shifting from Molecules to Electrons
- Role of Innovation and Potential of Carbon-free Hydrogen -

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Molecules to electrons

- Energy transition includes shifting away from fossil fuels to electricity.
- We can still use molecules in the form of “green” molecules in the zero-emission world.

Hydrogen

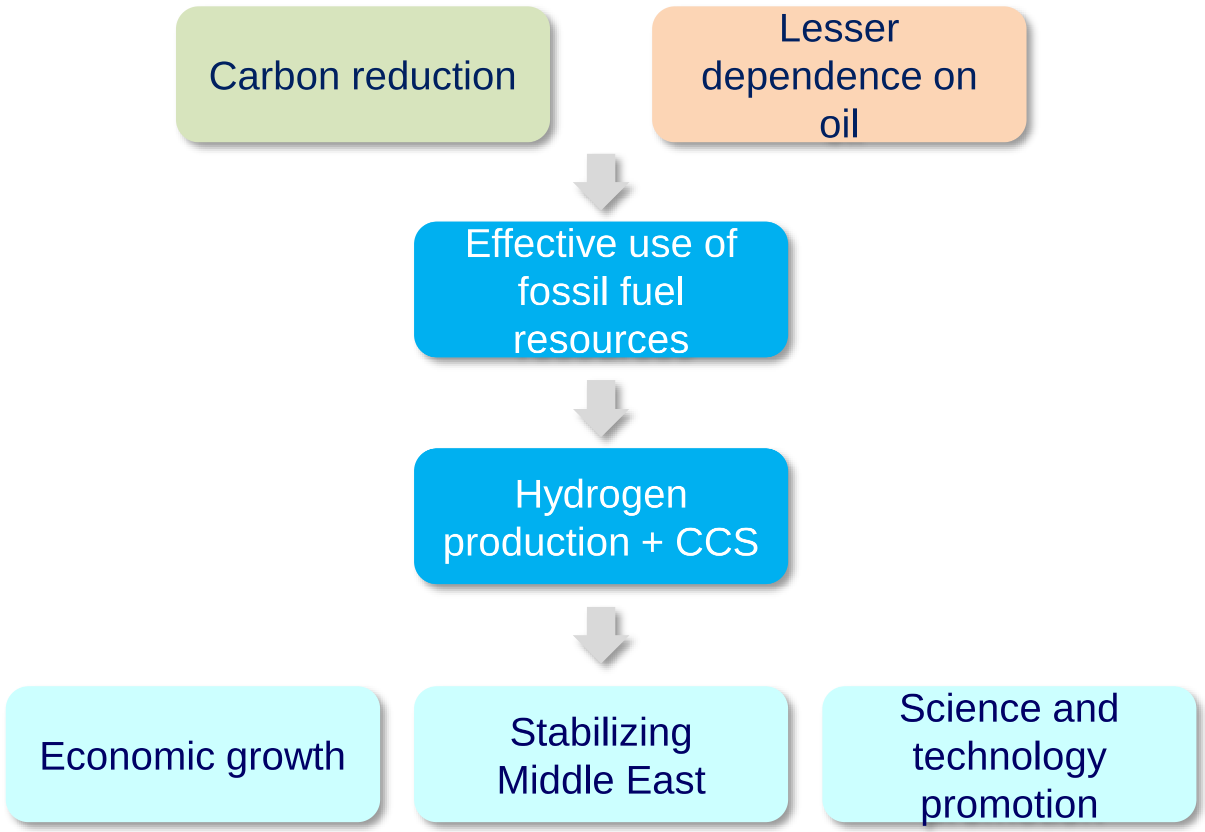
- High hopes are placed on hydrogen as a carrier of zero-carbon energy.
- Hydrogen can be produced from renewable energy, fossil fuels, and nuclear.

Important Role of Hydrogen

- Number one priority is addressing Climate Change
- Potential benefits :
  - to stabilize fossil fuel rich economies in Post-Oil-Age
  - to connect energy importing Asian countries with energy exporters in the zero-emission world
  - to store surplus renewable electricity

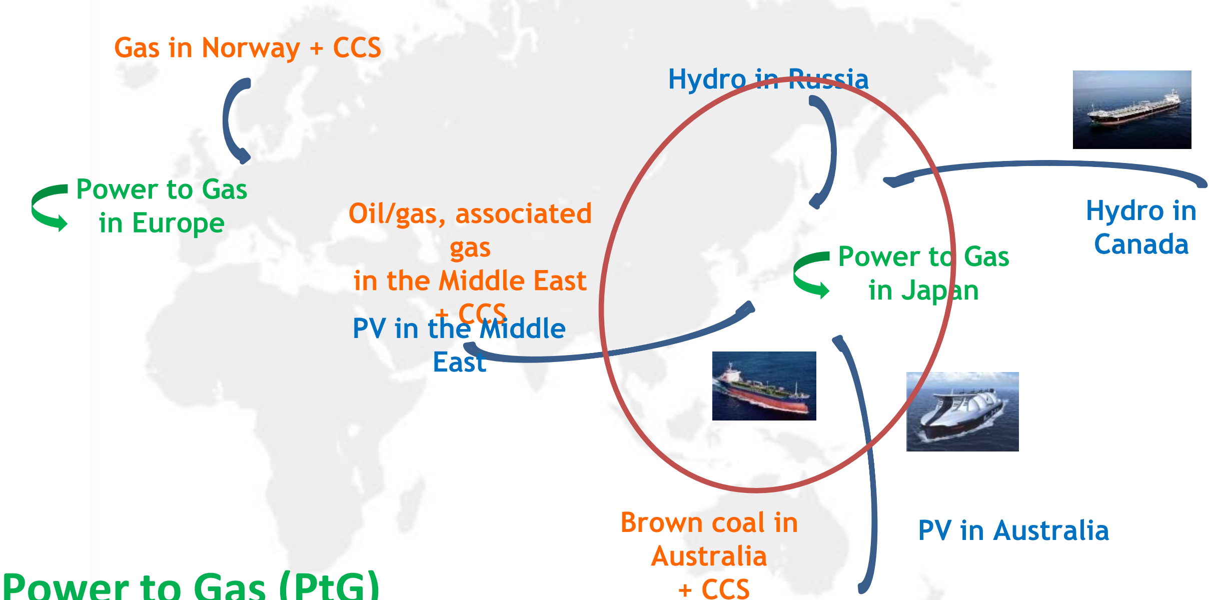
Source: IEEJ

Reducing Carbon Footprint While Making Use of Fossil Fuel Resources



CO_2-free Hydrogen

- **Large scale availability of H_2** (either from hydrocarbon + CCS or renewables)
  - ✓ A variety of concepts led by Japan, recently followed by Europe.
  - ✓ Around 2020, some of the ideas are to be demonstrated by Japanese companies.



- **Power to Gas (PtG)**
  - ✓ Led by Europe, recently followed by Japan.

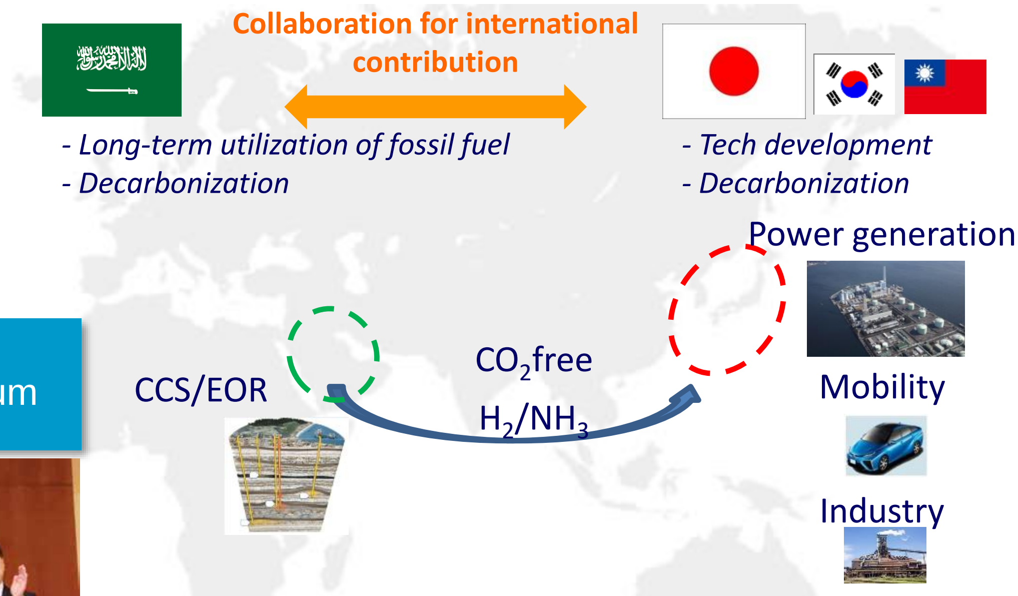
Co-Benefit: Japan & Middle East connected by H_2

- CO_2-free H_2/NH_3 through CCS/EOR is one of the decarbonization technologies in "Japan Saudi Vision 2030", bringing about co-benefit for both countries.
- IEEJ is collaborating with Saudi Aramco on this issue.

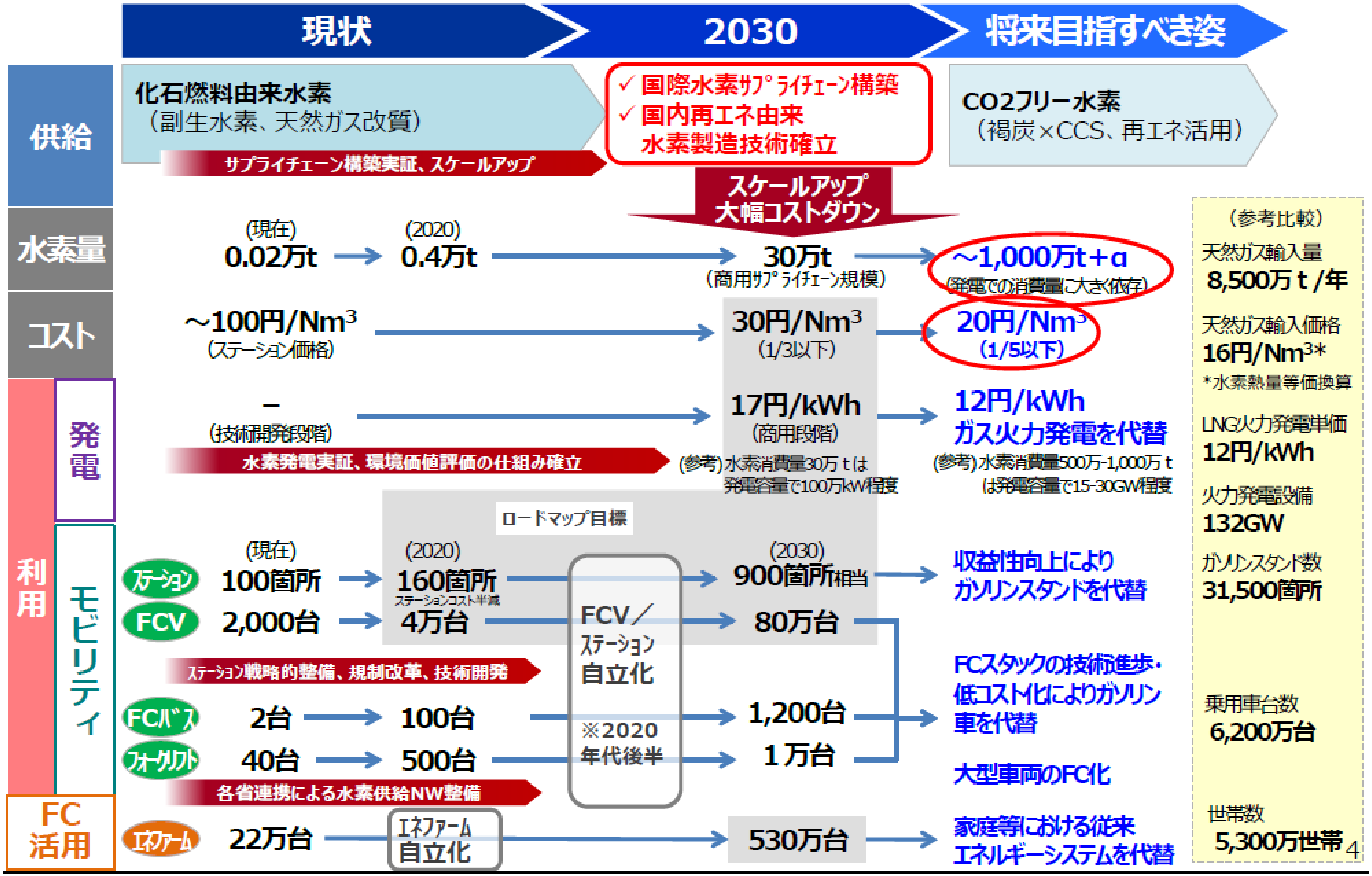
Saudi Japan Vision 2030
الرؤية السعودية اليابانية 2030

MOU (CO_2-free NH_3)
Japan Saudi Arabia Vision 2030 Business Forum
2019/6/17

CO_2 free H_2/NH_3 Supply Chain



水素基本戦略のシナリオ



戦略ロードマップ(水素、燃料電池)

水素・燃料電池戦略ロードマップ～水素社会実現に向けた産学官のアクションプラン～（全体）

- 基本戦略等で掲げた目標を確実に実現するため、

① **目指すべきターゲットを新たに設定(基盤技術のスペック・コスト内訳の目標)、達成に向けて必要な取組を規定**

② **有識者による評価WGを設置し、分野ごとのフォローアップを実施**

		基本戦略での目標	目指すべきターゲットの設定		ターゲット達成に向けた取組
利用	モビリティ	FCV 20万台@2025 80万台@2030	2025年	● **FCVとHVの価格差** (300万円→70万円) ● **FCV主要システムのコスト** (燃料電池 約2万円/kW→0.5万円/kW、水素貯蔵 約70万円→30万円)	• 徹底的な規制改革と技術開発
		ST 320か所@2025 900か所@2030	2025年	● **整備・運営費** (整備費 3.5億円→2億円、運営費 3.4千万円→1.5千万円) ● **ST構成機器のコスト** (圧縮機 0.9億円→0.5億円、蓄圧器 0.5億円→0.1億円)	• 全国的なSTネットワーク、土日営業の拡大 • ガソリンスタンド/コンビニ併設STの拡大
		バス 1200台@2030	20年代前半	● FCバス車両価格 (1億500万円→5250万円)	• バス対応STの拡大
				※トラック、船舶、鉄道分野での水素利用拡大に向け、指針策定や技術開発等を進める	
	発電	商用化@2030	2020年	● 水素専焼発電での**発電効率** (26%→27%) ※1MW級ガスタービン	• 高効率な燃焼器等の開発
	FC	グリッドパリティの早期実現	2025年	● 業務・産業用燃料電池のグリッドパリティの実現	• セルスタックの技術開発
供給	化石+CCS	水素コスト 30円/Nm3@2030 20円/Nm3@将来	20年代前半	● 製造：褐炭ガス化による**製造コスト** (数百円/Nm3→12円/Nm3) ● 貯蔵・輸送：液化水素**タンクの規模** (数千m³→5万m³) 水素**液化効率** (13.6kWh/kg→6kWh/kg)	• 褐炭ガス化炉の大型化・高効率化 • 液化水素タンクの断熱性向上・大型化
	再エネ水素	水電解システムコスト 5万円/kW@将来	2030年	● 水電解**装置のコスト** (20万円/kW→5万円/kW) ● 水電解効率 (5kWh/Nm3→4.3kWh/Nm3)	• 浪江実証成果を活かしたモデル地域実証 • 水電解装置の高効率化・耐久性向上 • 地域資源を活用した水素サプライチェーン構築

"Hydrogen Energy Ministerial Meeting"

Tokyo Statement (2018)

- 1.Collaboration on Technologies and Coordination on Harmonization of Regulation, Codes and Standards
- 2. Promotion of Information Sharing, International Joint Research and Development Emphasizing Hydrogen Safety and Infrastructure Supply Chain
- 3. Study and Evaluation of Hydrogen's Potential across Sectors Including Its Potential for Reducing Both CO2 Emissions and Other Pollutants
- 4. Communication, Education and Outreach

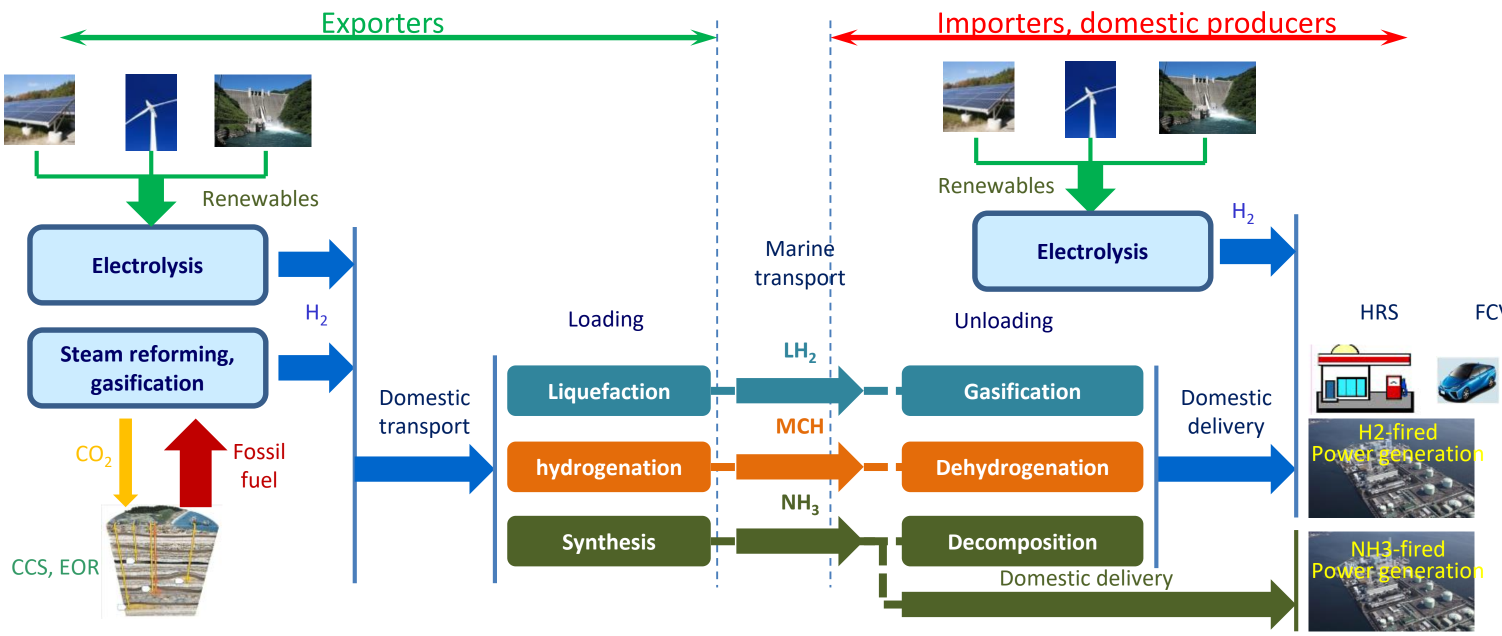
Global Action Agenda of Tokyo Statement (2019)

The Ministers and Delegates recognize the importance of tackling challenges to scale up hydrogen comprehensively, including by formulating long-term strategies or roadmaps and identifying challenges and the necessary policies and programs to implement change. They encourage actions on the following items, where appropriate, in line with the four pillars in the Tokyo Statement, while taking into account different national circumstances

Source: METI

Large Scale H_2 Is Essential

- In terms of economics, large-scale supply chain is *sine qua non*
- Transport has three options, liquefied hydrogen (LH_2), methylcyclohexane (MCH) and ammonia (NH_3).



Note: LH_2 is liquefied hydrogen, MCH is methylcyclohexane, NH_3 is ammonia

Examples of Potential Hydrogen Users: Demand Creation is Required

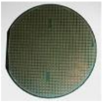
Industrial Use

- Large-scale use
  15 billion Nm^3/y for oil refining, petrochemicals, ammonia, etc. in Japan
- Small-scale use
  300 million Nm^3/y in Japan at present

Stainless steel bright annealing

Glass

Hydrogenated fat, margarine



Semiconductor

Energy Use

- FCV, hydrogen station

800,000 units @2030
: 800 million Nm^3

- Hydrogen burning power generation

1GW=2-3 billion Nm^3

- Industry sector

For steelmaking (hydrogen reduction steelmaking), boilers, burners, etc. in future

- Natural gas pipeline

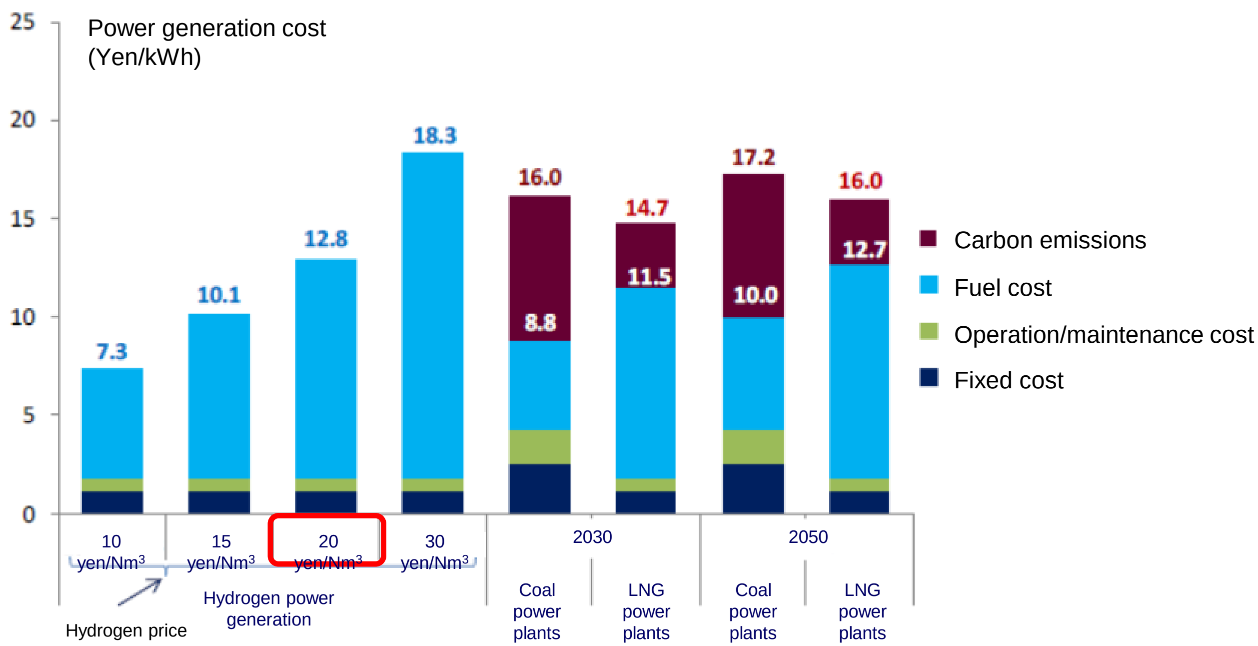
Hurdles are lower for synthetic methane

- Buildings sector

Future hydrogen town?

Target Hydrogen Import Cost

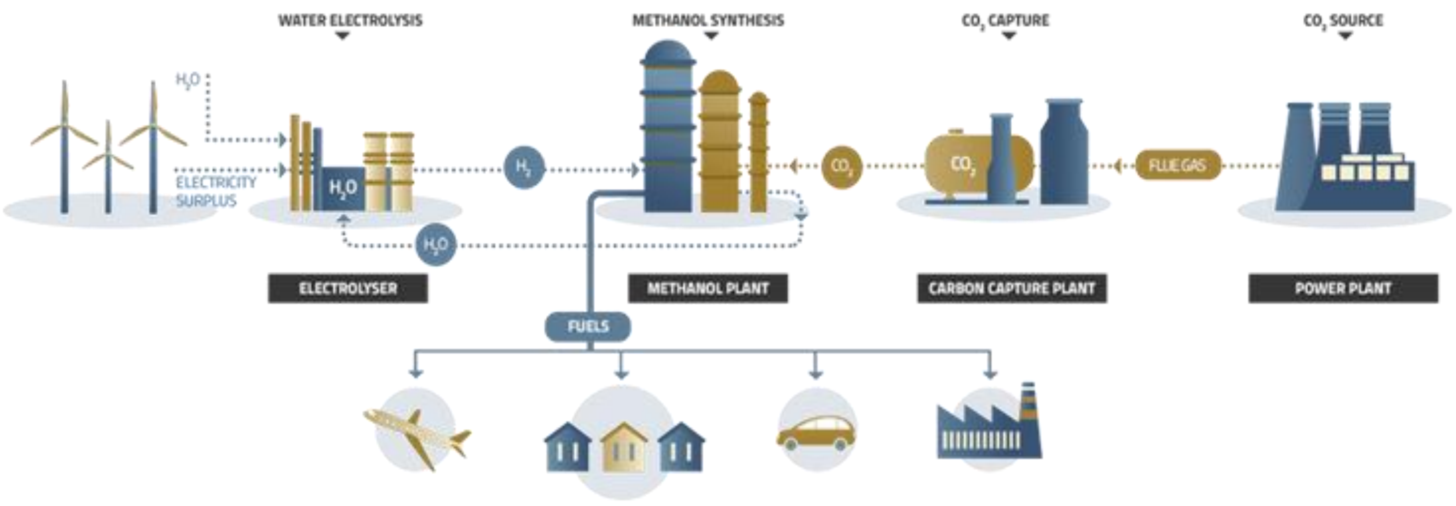
- Given Japan's hydrogen use for power generation, the desirable hydrogen CIF import price is **20 yen /Nm³ or less**.
The **Japanese government has set its target at 30 yen /Nm³**.



Source: IEEJ

A Variety of PtG Configuration in Europe: One Example

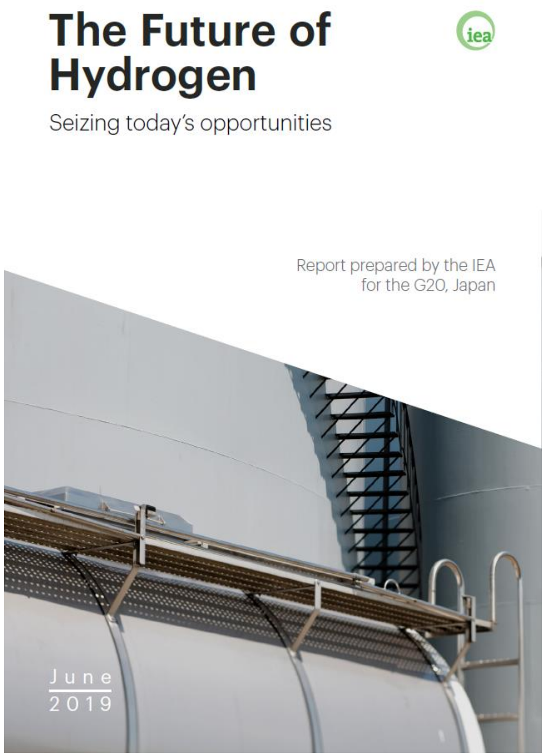
Synthetic Methanol



IEA's Hydrogen Report

- IEA report "The Future of Hydrogen" (2019/6) makes recommendations on how to scale up hydrogen.

- 1. Establish a role for hydrogen in long-term energy strategies
- 2. Stimulate commercial demand for clean hydrogen
- 3. Address investment risks of first-movers
- 4. Support R&D to bring down costs
- 5. Eliminate unnecessary regulatory barriers and harmonise standards
- 6. Engage internationally and track progress
- 7. Focus on four key opportunities to further increase momentum over the next decade.
  - ✓ Make industrial ports the nerve centres for scaling up the use of clean hydrogen
  - ✓ Build on existing infrastructure, such as millions of kilometres of natural gas pipelines
  - ✓ Expand hydrogen in transport through fleets, freight and corridors
  - ✓ Launch the hydrogen trade's first international shipping routes



Source: IEA

Conclusion

■ **Hydrogen will play important roles** in the "post oil age"

1) To address Climate Change
2) To stabilize fossil fuel rich economies

■ **Possible ways to produce zero carbon hydrogen**

a) from fossil fuels in combination with CCS
b) through electrolysis from green electrons

■ **Challenges are;**

i) To reduce the cost of zero-carbon hydrogen
ii) To diversify the use of hydrogen;
not only for transportation use but for power generation and industry

Therefore;

International collaboration is essential for speeding up this process

Energy Transition and Role of Hydrogen

おまけ：General Questions for the Panel

- How can hydrogen contribute to the "energy transition"?
- What specific areas, usage, systems and technologies have potential applications for hydrogen? Any examples and best practices of ongoing projects?
- What are the foreseen challenges ? How can we address them?
- What is our way forward?

- UAEへの提言 : Establishing Hydrogen Master Plan is recommended, in which;

✓ Objectives: Decarbonization and (or) natural gas export increase
✓ Target and target year should be set.
✓ How to produce hydrogen and what applications?
✓ What technologies should be included?
✓ Cost target for hydrogen; production, transport & storage and application
✓ Draw technology roadmap
✓ What policy and supporting mechanism is required?
✓ Potential of collaboration with Japan

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