Government Perspective (Japan)

– Basic Hydrogen Strategy –

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Mission/ Background

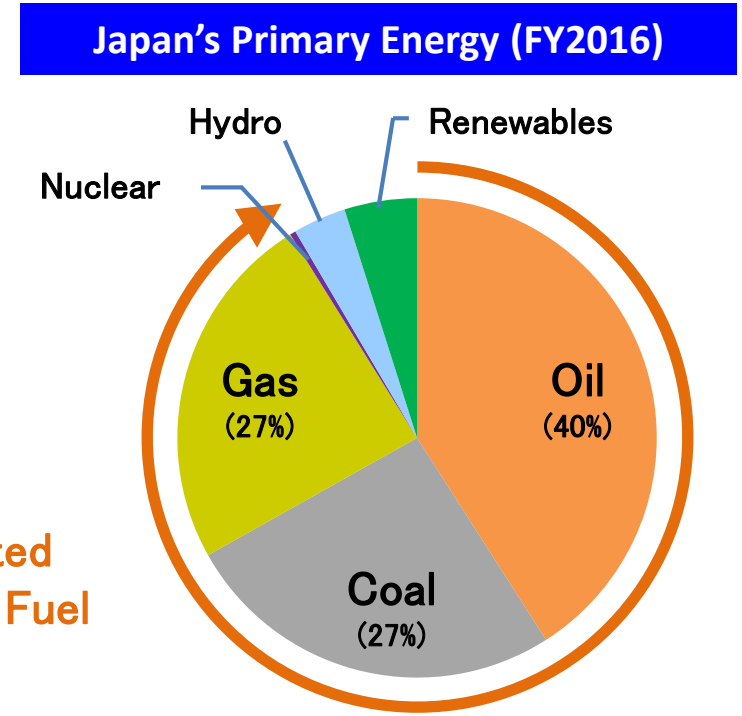
- **Japan's Responsibility for Energy Transition**

  ⇔ **Energy trilemma**

  - ✓ Energy security
  - ✓ Environment (Sustainability)
  - ✓ Economic affordability (Cost)

  } 3"E" + Safety

- **Measures;**
  - ✓ Energy saving
  - ✓ Renewable energy
  - ✓ Nuclear energy
  - ✓ CCS + Fossil fuels
  - ✓ Hydrogen



Why Hydrogen?

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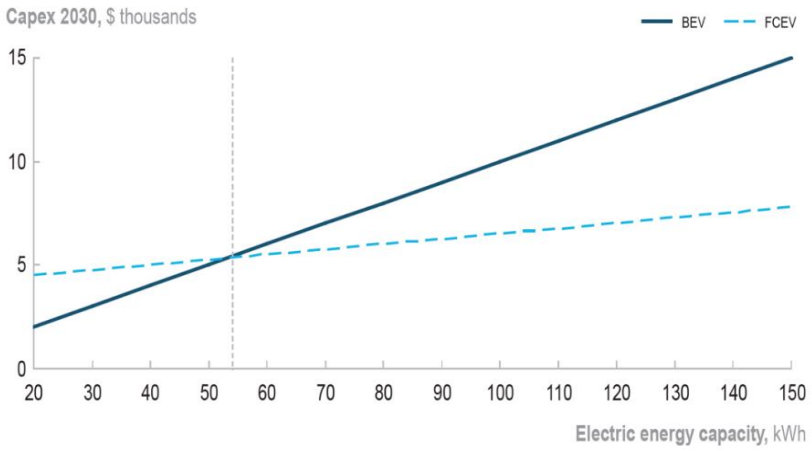
- **Contribution to 3"E"**
  - ✓ Contribute **de-carbonization** (Environment)
  - ✓ Mitigate **dependence on specific countries** (Energy security)
  - ✓ Enable to utilize **low cost feedstock** (Economic affordability)

  + Japan's edge in technology since 1970s

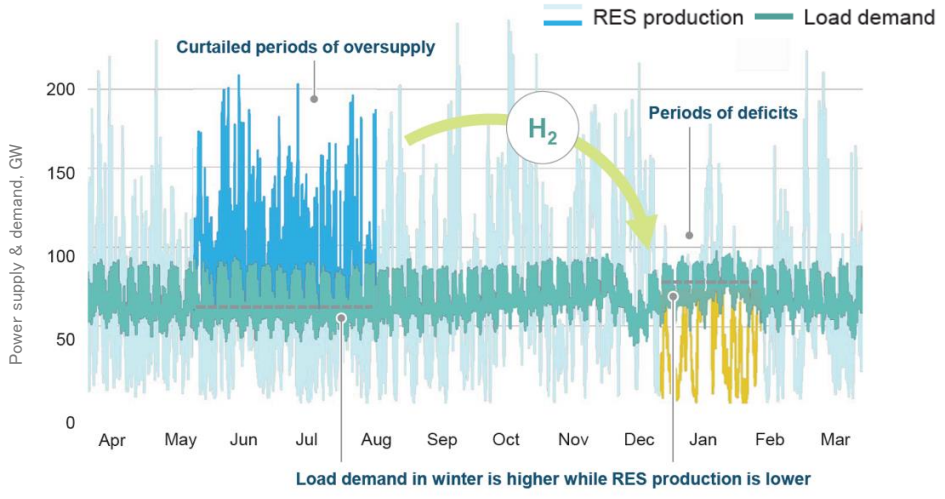
- **Roles of H_2 in Electrified Mobility/ Generation Mix**

Powertrain Costs Analysis for FCEVs & BEVs



Source: "Hydrogen Scaling Up", Hydrogen Council (2017)

Power Supply & Demand Simulation for Germany in 2050



Source: "How Hydrogen Empowers the Energy Transition", Hydrogen Council (2017)

Direction of Activities to Realize a "Hydrogen Society"

Production

Domestic fossil fuels
- City gas / LP gas → Reforming
- Byproduct hydrogen

Future

Overseas unused energy
- Brown coal → Gasification → CCS
- Byproduct hydrogen
- Overseas renewable energy → Water electrolysis

Renewable energy
- Solar power
- Wind power
→ Water electrolysis

*Use hydrogen as a means of energy storage (absorb fluctuations in intermittent RES)

- Demonstration of large-scale power-to-gas @Fukushima/aiming for use in the 2020 Tokyo Olympic and Paralympic Games

Transportation and supply (supply chain)

City gas pipeline/LPG supply network
Liquefied hydrogen lorry
Hydrogen pipeline

- Installation of 103 stations nationwide
- Promotion of regulatory reform for cost reduction

Hydrogen station

- Demonstration of the world's first international hydrogen supply chain in 2020

Large-scale hydrogen ocean Transportation network

Use

Transportation

- 3,000 vehicles installed
- 40,000 vehicles by 2020

Fuel cell vehicles (FCV, FC bus, etc.)

- Entered service in Tokyo in March 2017
- 100 buses by 2020

Power generation

- Over 270,000 units installed

Fuel cell cogeneration (e.g. Ene-Farm)

Reforming

- For Business and Industry use, some models have already been launched in 2017

Future

Hydrogen power generation (CO_2-free thermal power plants)

- Combined heat and power supply using hydrogen cogeneration in Kobe in early 2018

Other

Use in the industrial sector (Power-to-X)

Basic Hydrogen Strategy

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- **"Basic Hydrogen Strategy" (Prime Minister Abe's Initiative)**
  - ✓ **World's first national strategy**
  - ✓ **2050 Vision: position H_2 as a new energy option** (following Renewables)
  - ✓ **Target: make H_2 affordable** ($3/kg by 2030 ⇒ $2/kg by 2050)

3 conditions for realizing affordable hydrogen

【Supply】 ① **Inexpensive feedstock** (unused resources, renewables)
② **Large scale H_2 supply chains**

【Demand】 ・・・ ③ **Mass usage** (Mobility ⇒ Power Generation ⇒ Industry)

- **Key Technologies to be Developed**

Production	Transportation	Use
• Electrolysis System • Gasification + CCS	• Energy Carrier (LH_2, MCH, NH_3, etc.)	• Fuel Cells (Mobility, Generation) • H_2-fired Generation

Basic Hydrogen Strategy (Scenario)

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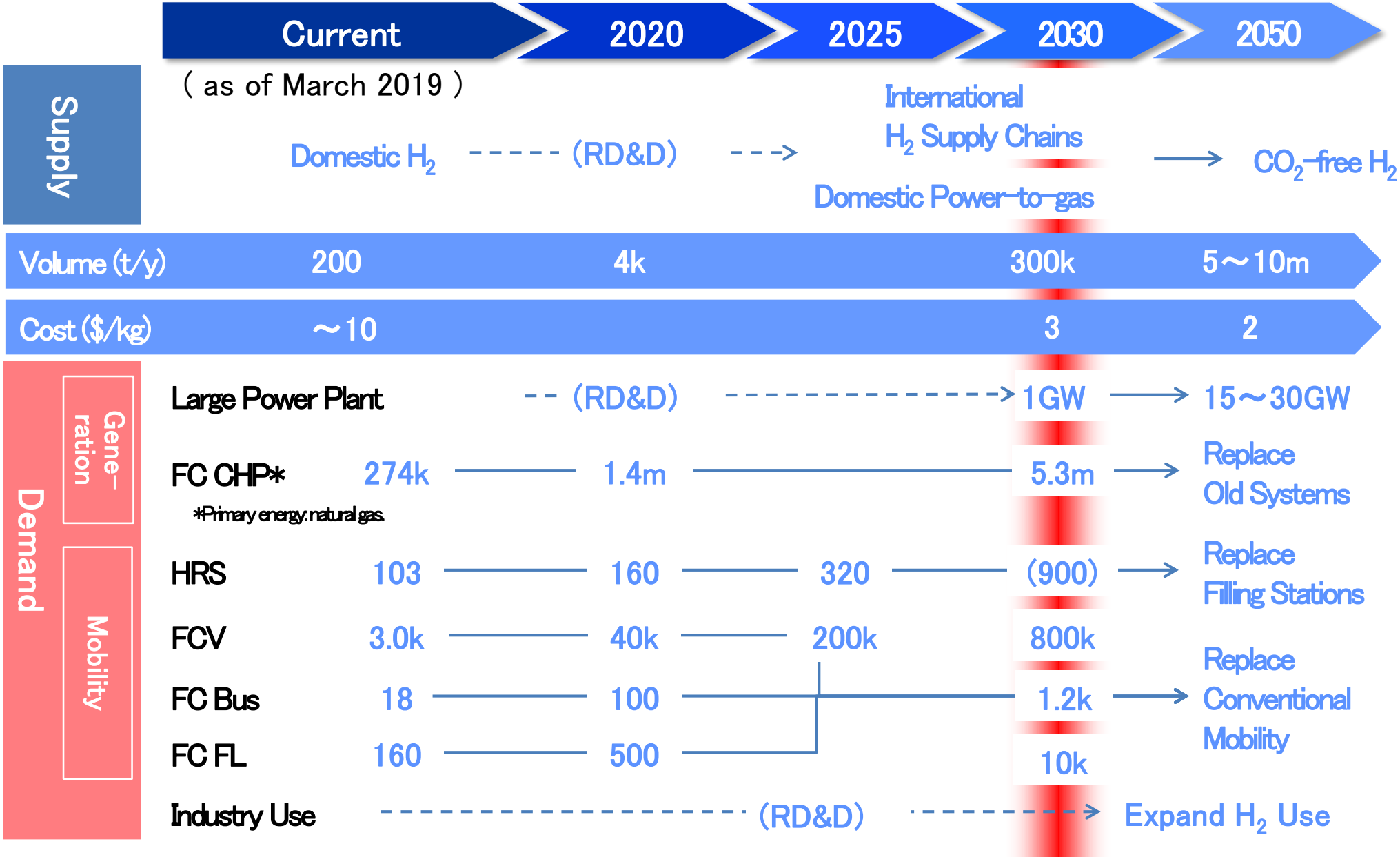


Summary of the Strategic Road Map for Hydrogen and Fuel Cells

- Set of new target to achieve (Spec for basic technologies and cost breakdown goals)

- ✓ **Price difference between FCV and HV:** ￥3m → ¥0.7m
- ✓ **Main FCV System cost, FC** : ¥20,000/kW → ¥5,000/kW,
  Storage : ¥0.7m → ¥0.3m
- ✓ **HRS Construction cost:** ¥350m → ¥200m
- ✓ **HRS Operating cost:** ¥34m/year → ¥15m/year
- ✓ **HRS components cost**
  Compressor: ¥90m → ¥50m
  Accumulator: ¥50m → ¥10m
- ✓ **Production cost from brown coal gasification:**
  several hundreds JPY/Nm3→ ¥12/Nm3
- ✓ **Electrolyzer Cost:** ¥200,000m/kW→¥50,000/kW

The Strategic Road Map for Hydrogen and Fuel Cells ～ Industry-academia-government action plan to realize Hydrogen Society ～(overall)

- In order to achieve goals set in the Basic Hydrogen Strategy,

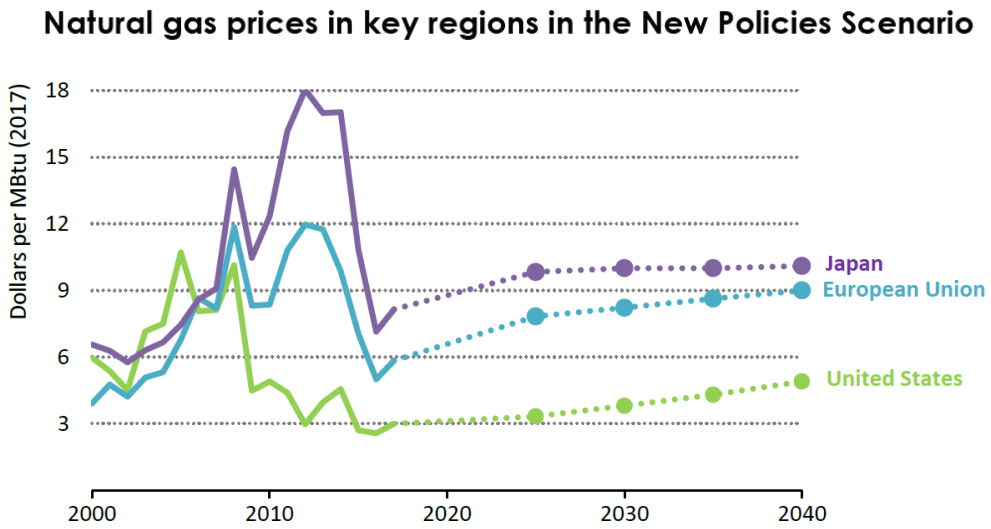
① Set of new targets to achieve (Specs for basic technologies and cost breakdown goals), establish approach to achieving target

② Establish expert committee to evaluate and conduct follow-up for each field.

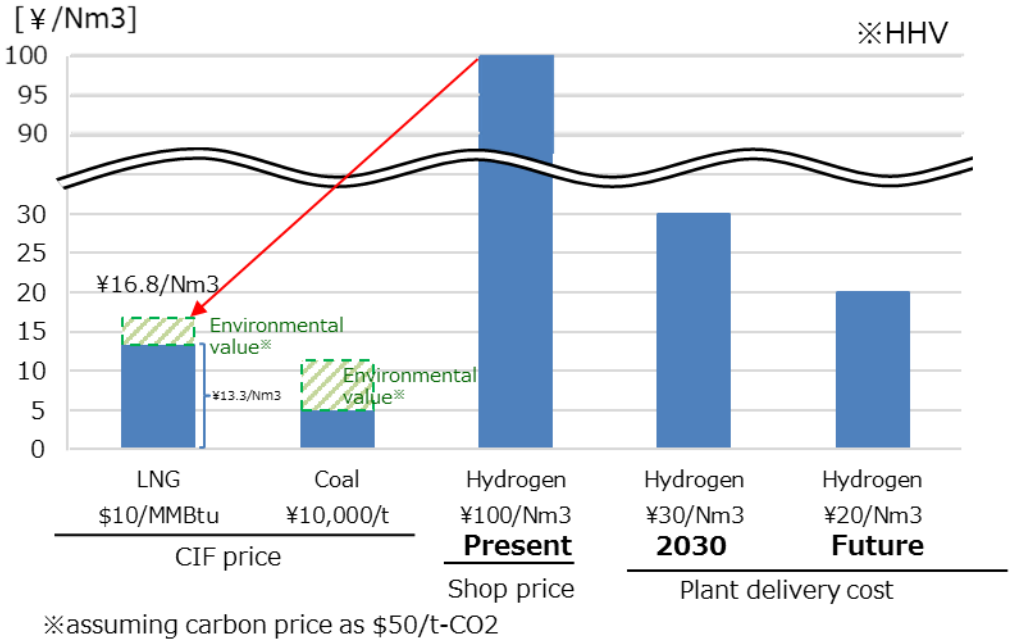
		Goals in the Basic Hydrogen Strategy	Set of targets to achieve		Approach to achieving target
Use	Mobility	FCV 200k by 2025 800k by 2030	2025	● Price difference between FCV and HV (¥3m → ¥0.7m)	• Regulatory reform and developing technology
				● Cost of main FCV system FC ¥20,000/kW → ¥5,000/kW Hydrogen Storage ¥0.7m → ¥0.3m	
		HRS 320 by 2025 900 by 2030	2025	● Construction and operating costs Construction cost ¥350m → ¥200m Operating cost ¥34m/year → ¥15m/year	• Consideration for creating nation wide network of HRS • Extending hours of operation
				● HRS components cost Compressor ¥90m → ¥50m Accumulator ¥50m → ¥10m	
		Bus 1,200 by 2030	Early 2020s	● Vehicle cost of FC bus (¥105m → ¥52.5m)	• Increasing HRS for FC bus
			※In addition, promote development of guidelines and technology development for expansion of hydrogen use in the field of FC trucks, ships and trains.		
	Power	Commercialize by 2030	2020	● Efficiency of hydrogen power generation(26%→27%) ※1MW scale	• Developing of high efficiency combustor etc.
	FC	Early realization of grid parity	2025	● Realization of grid parity in commercial and industrial use	• Developing FC cell/stack technology
Supply	Fossil Fuel +CCS	Hydrogen Cost ¥30/Nm3 by 2030 ¥20/Nm3 in future	Early 2020s	● Production: Production cost from brown coal gasification (¥several hundred/Nm3→ ¥12/Nm3)	• Scaling-up and improving efficiency of brown coal gasifier • Scaling-up and improving thermal insulation properties
				● Storage/Transport : Scale-up of Liquefied hydrogen tank (thousands m³→50,000m³) Higher efficiency of Liquefaction (13.6kWh/kg→6kWh/kg)	
	Green H2	System cost of water electrolysis ¥50,000/kW in future	2030	● Cost of electrolyzer (¥200,000m/kW→¥50,000/kW) ● Efficiency of water electrolysis (5kWh/Nm3→4.3kWh/Nm3)	• Demonstration in model regions for social deployment utilizing the achievement in the demonstration of Namie, Fukushima • Development of electrolyzer with higher efficiency and durability

Hydrogen Cost Targets

- In order to achieve grid parity, Hydrogen cost is needed to be lower than price of natural gas.
- Target of hydrogen importing cost in Japan has to be ￥13/Nm^3 in future (US$1.3/kg, equivalent to US$10/MMBtu).



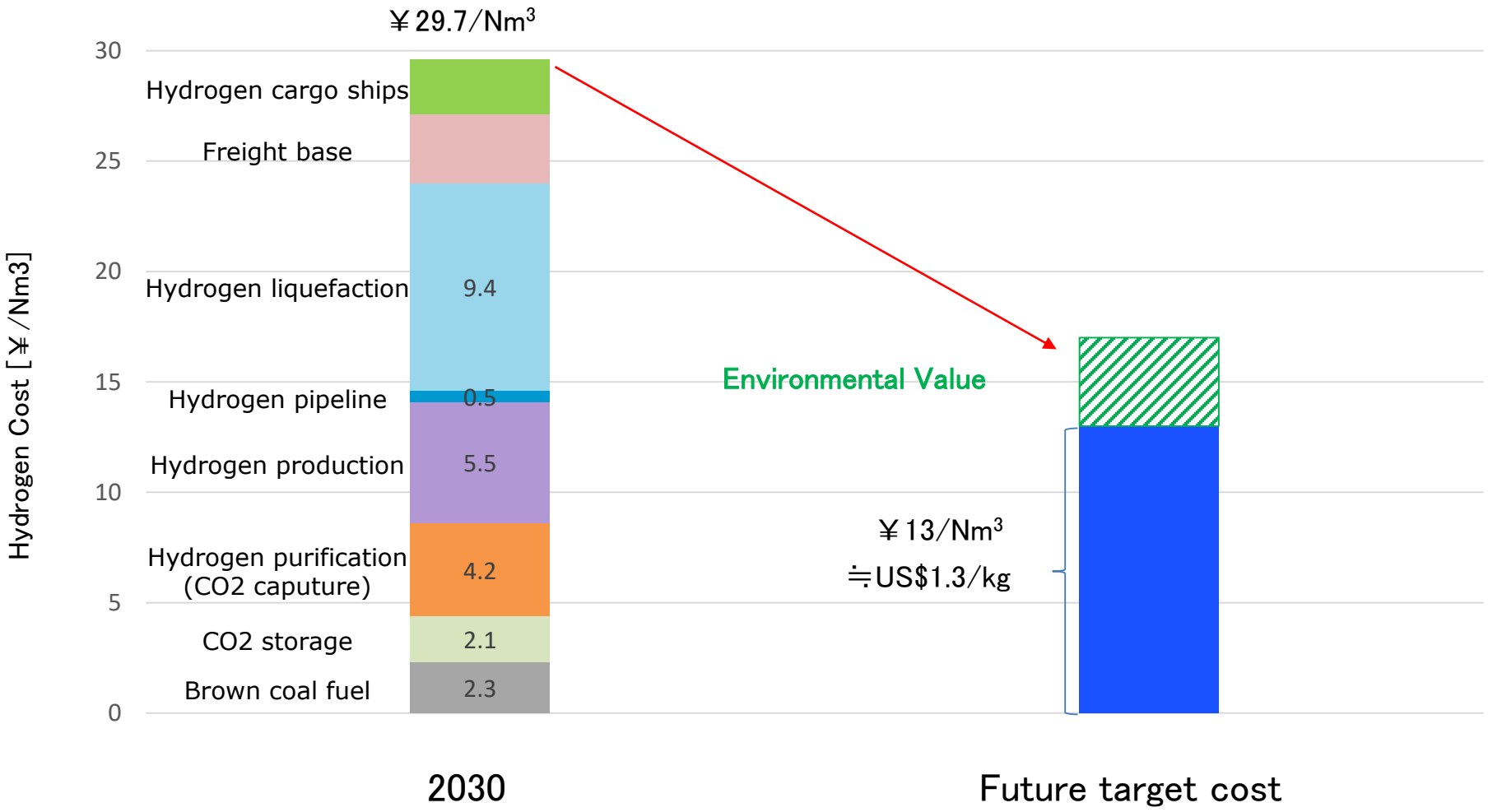
from World Energy Outlook 2018 (IEA)



※assuming carbon price as $50/t-CO2

Hydrogen Cost Perspective of the Supply Chain Project

- Target cost of hydrogen supply in 2030 is ￥30/Nm^3.
- Natural gas price is unpredictable, however further cost reduction is needed.



Ongoing Projects (Supply-side)

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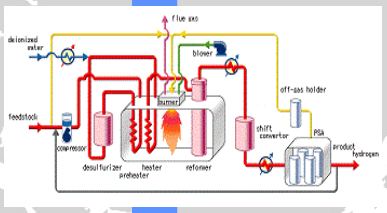
International H_2 Supply Chain

Japan-Brunai Pilot Project

2020～ AHEAD

Off-gas

Steam Methane Reforming



Hydro-genation*
(TOL→MCH)

Chemical Tanker

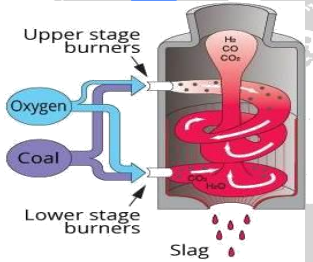
Dehydro-genation*
(MCH→TOL)

Japan-Australia Pilot Project

2020～ HySTRA

Brown Coal +CCS

Gasification



Liquefied H_2 Carrier*

Loading Facility*

Power-to-gas

Fukushima Renewable H_2 Project

2020～ FH2R FUKUSHIMA HYDROGEN ENERGY RESEARCH FIELD

Power-to-Gas Plant*

Electrolysis System (Alkaline)

TOKYO 2020 TOKYO 2020

* Image

Ongoing Projects (Demand-side)

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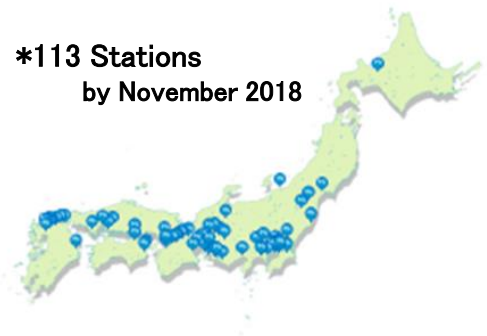
H_2 Mobility

H_2 Station Network

2013～



*113 Stations
by November 2018

H_2 Applications

2016～

FC Bus

× 100 in 2020

FC Truck Demo

Joint Venture for H_2 Infrastructure Development

2018～

H_2 Power Generation

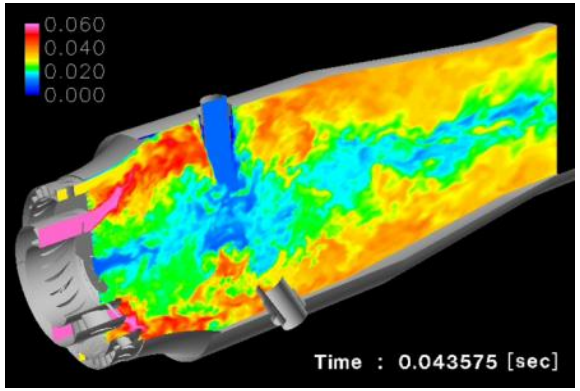
H_2 Co-generation Demonstration Project

Hydrogen Gas
Turbine (1MW class)

2018～

R&D of H_2 Burner Systems

For Power
Generation
<500MW



Burning Simulation
(H_2 + CH_4)

G20 Ministerial Meeting on Energy Transitions and Global Environment for Sustainable Growth

- Date: June 15th, 16th, 2019
- Venue: Karuizawa, Japan
- Expected outcome :
  - ✓ Communique
  - ✓ Action Plan

- Hydrogen

✓The importance of hydrogen will be referred in the Communique and Action Plan.
* It will be the first time to be mentioned on hydrogen in G20 Ministerial Communique.
✓Hydrogen Report will be released at G20 by IEA
✓One of the main themes of G20 Exhibition in Karuizawa is Hydrogen.
✓Over FCVs are used for transportation of Ministers in the venue
✓ Presentation and input about hydrogen by Hydrogen Council

Hydrogen Energy Ministerial Meeting

Hydrogen Energy Ministerial Meeting
H2EM 2018

- Date / Place: October 23rd, 2018 / Dai-ichi Hotel Tokyo
- Organized by: METI , New Energy and Industrial Technology Development Organization (NEDO)
- Participants: 300 people including representatives from 21 countries, regions, international organizations, etc.*

*Japan, Australia, Austria, Brunei, Canada, China, France, Germany, Italy, the Netherlands, New Zealand, Norway, Poland, Qatar, South Africa, Korea, United Arab Emirates, United Kingdom, United States, European Commission, IEA
Participants:

PROGRAM

●Ministerial Session
●Industry and International Organization Session

- Plenary Session: Potential of Hydrogen Energy for Energy Transition
- Session 1: Expansion of Hydrogen Use – Mobility & H2 Infrastructure –
- Session 2: Upstream & Global Supply-chain for Global Hydrogen utilization
- Session 3:Renewable Energy Integration & Sectoral Integration

Tokyo Statement

We share the view that hydrogen can be a key contributor to the energy transitions underway to clean energy future and an important component of a broad-based, secure, and efficient energy portfolio. Also, we confirmed the value of collaborating on the following four agendas on "Tokyo Statement" to achieve a "Hydrogen Society" .

◆Harmonization of Regulation, Codes and Standards
◆International Joint R&D emphasizing Safety
◆Study and Evaluate Hydrogen's Potential
◆Communication, Education and Outreach

*Hydrogen Energy Ministerial Meeting 2019 is scheduled for September 25th in Tokyo. (tentative)