Challenges for Japan's Energy Transition

- Basic Hydrogen Strategy -

March 19th

Agency for Natural Resources and Energy (ANRE),
Ministry of Economy, Trade and Industry (METI), Japan

Mission/ Background

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

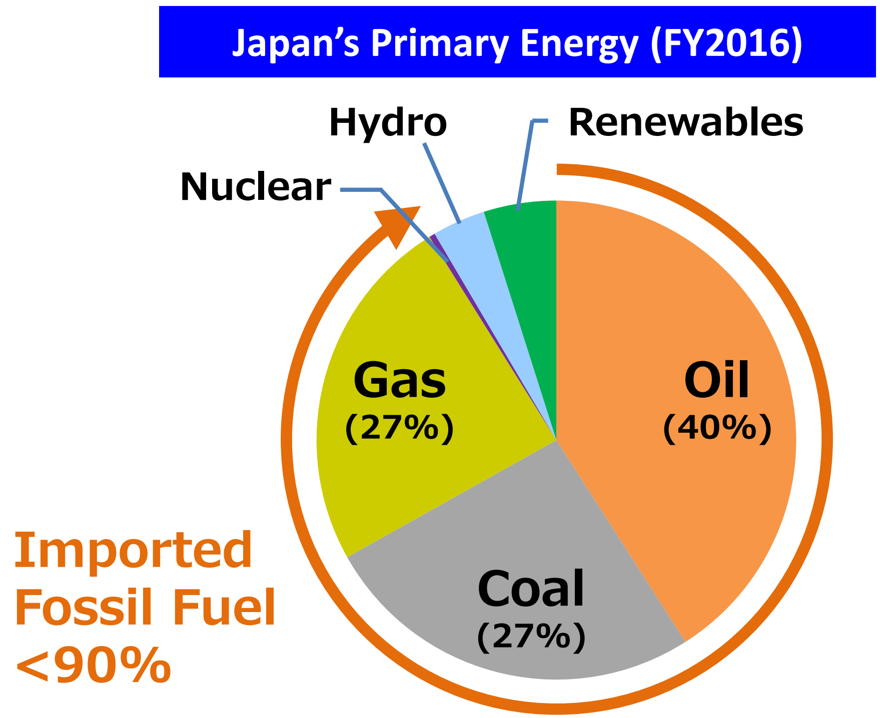
  ⇔ **Energy trilemma**

  ✓ **E**nergy security
  ✓ **E**nvironment (Sustainability)
  ✓ **E**conomic affordability (Cost)

  } **3"E"** + **S**afety

- **Measures;**

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



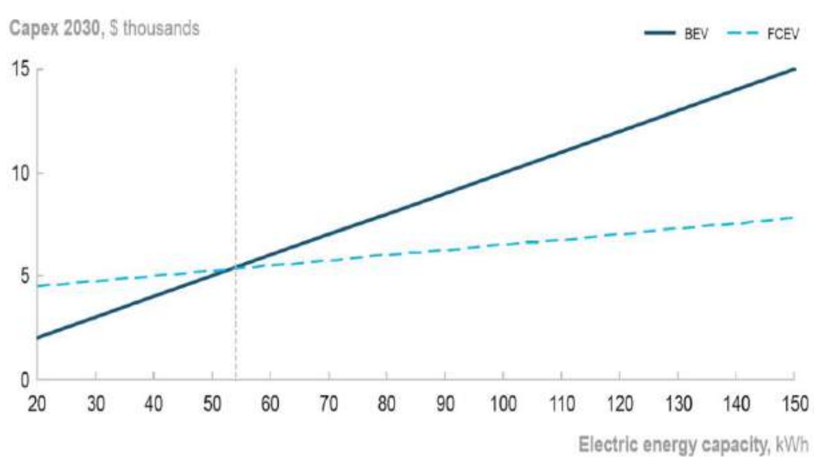
Why Hydrogen?

METI Ministry of Economy, Trade and Industry

- **Contribution to 3"E"**
  - ✓ Contribute **de-carbonization** (**E**nvironment)
  - ✓ Mitigate **dependence on specific countries** (**E**nergy security)
  - ✓ Enable to utilize **low cost feedstock** (**E**conomic affordability)
  - \+ **Japan's edge in technology** since 1970s

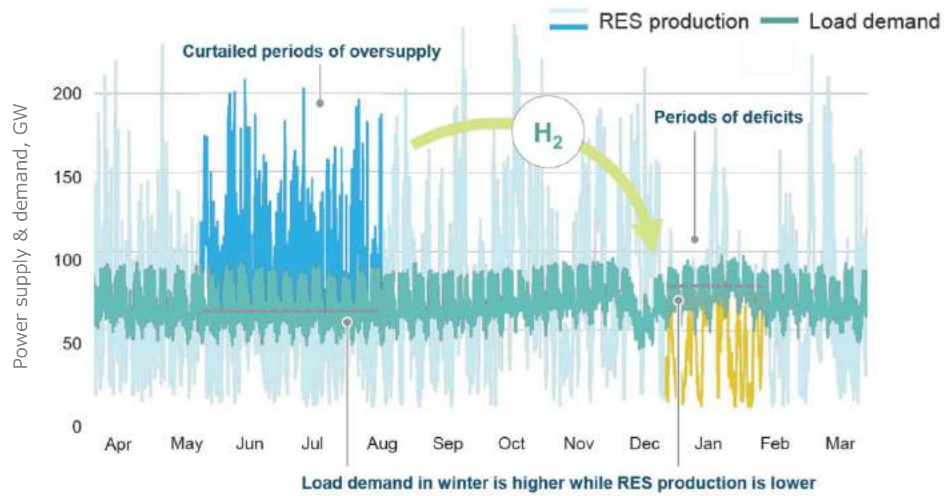
- **Roles of H_2 in Electrified Mobility/ Generation Mix**

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)

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
- Electrolysis System
- Gasification + CCS

→

Transportation
- Energy Carrier
  (LH_2, MCH, NH_3, etc.)

→

Use
- Fuel Cells (Mobility, Generation)
- H_2-fired Generation

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 113 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 274,000 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 2018

Other

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

Scenario

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		Current	2020	2025	2030	2050
Supply		Domestic H_2	(RD&D)		International H_2 Supply Chains / Domestic Power-to-gas	CO_2-free H_2
Volume (t/y)		200	4k		300k	5～10m
Cost ($/kg)		～10			3	2
Demand – Generation	Large Power Plant		(RD&D)		1GW	15～30GW
	FC CHP*	274k	1.4m		5.3m	Replace Old Systems
Demand – Mobility	HRS	113	160	320	(900)	Replace Filling Stations
	FCV	2.9k	40k	200k	800k	Replace Conventional Mobility
	FC Bus	5	100		1.2k	
	FC FL	140	500		10k	
Demand	Industry Use			(RD&D)		Expand H_2 Use

*Primary energy: natural gas.

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 b y2025 800k by 2030	2025	● **Price difference between FCV and HV** (¥3m → ¥0.7m) ● **Cost of main FCV system** (FC ¥20k/kW → ¥5k/kW; Hydrogen Storage ¥0.7m → ¥0.3m)	• Regulatory reform and developing technology
		HRS 320 by 2025 900 by 2030	2025	● **Construction and operating costs** (Construction cost ¥350m → ¥200m; Operating cost ¥34m→¥15m) ● **Costs of components for HRS** (Compressor ¥90m → ¥50m; Accumulator¥50m → ¥10m)	• Consideration for creating nation wide network of HRS • Extending hours of operation
		Bus 1,200 by 2030	Early 2020s	● Vehicle cost of FC bus (¥105m → ¥52.5m) ※In addition, promote development of guidelines and technology development for expansion of hydrogen use in the field of FC trucks, ships and trains.	• Increasing HRS for FC bus
	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) ● Storage/Transport：Scale-up of Liquefied hydrogen tank (thousands m³→50,000m³) Higher efficiency of Liquefaction (13.6kWh/kg→6kWh/kg)	• Scaling-up and improving efficiency of brown coal gasifier • Scaling-up and improving thermal insulation properties
	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

Ongoing Projects (Supply-side)

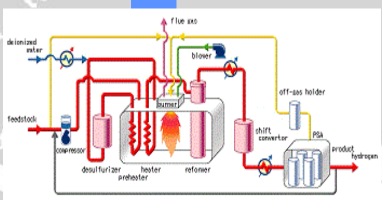
International H_2 Supply Chain

Japan-Brunai Pilot Project

2020～ AHEAD

Off-gas

Steam Methane Reforming



Hydro-genation* (TOL→MCH)

Chemical Tanker

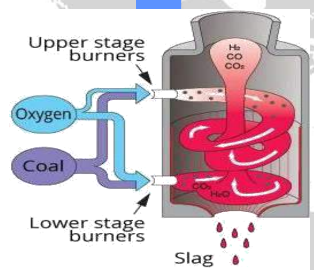
Dehydro-genation* (MCH→TOL)

Japan-Australia Pilot Project

2020～ HySTRA

Brown Coal +CCS

Gasification



Liquefied H_2 Carrier*

Loading Facility*

Power-to-gas

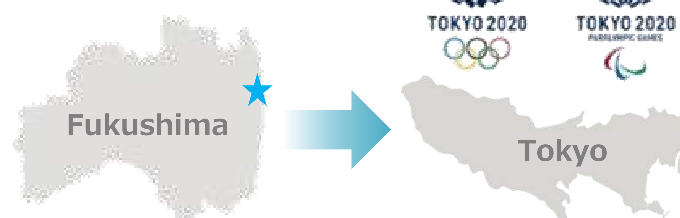
Fukushima Renewable H_2 Project

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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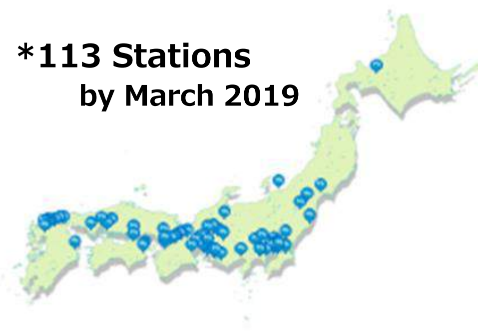
H_2 Mobility

H_2 Station Network

2013～

*113 Stations
by March 2019



H_2 Applications

2016～

FC Bus

× 100 in 2020

FC Truck Demo

Joint Venture for H_2 Infrastructure Development

2018～

HONDA
NISSAN
JXTG Group
IDEMITSU
TOYOTA
JAPAN H₂ MOBILITY
JHyM
Iwatani
TOKYO GAS
DBJ
TOHO GAS
TOYOTA TSUSHO
Air Liquide
creative oxygen

H_2 Power Generation

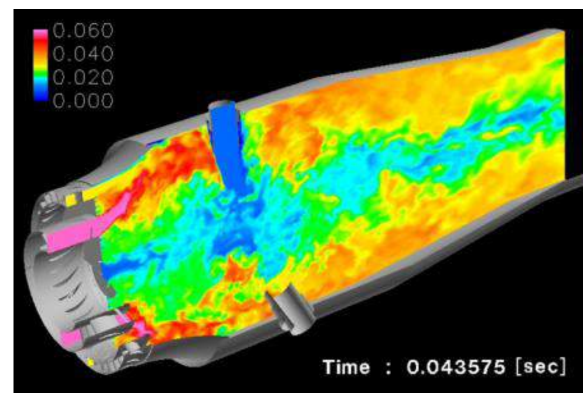
H_2 Co-generation Demonstration Project

Hydrogen Gas Turbine (1MW class)

2018～

R&D of H_2 Burner Systems

For Power Generation <500MW



Burning Simulation (H_2 + CH_4)

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)