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) ● **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)	• Designated regions for public deployment demonstration tests utilizing the outcomes of the demonstration test in Namie, Fukushima • Development of electrolyzer with higher efficiency and durability

Action Plan (key point) ① <Hydrogen Use (Mobility) >

Red : New target

In order to reduce cost for full-scale implementation period, thorough establishment of mass production technology and implementation of regulatory reform

Hydrogen Use (Mobility)

	Target to achieve	Approach to achieving target
FCV	● 200k by FY2025, 800k by FY2030 ● Achieving a cost reduction of FCV to the level of HV around 2025 （ Price difference ¥3m → ¥0.7m） ● Reducing cost of main elemental technologies around 2025 （Fuel cell system around ¥20k/kW→¥5k/kW Hydrogen storage system around ¥0.7m → ¥0.3m） Expansion of vehicle types for volume zones in FY2025	• Sharing technical information and problems in a cooperation area among stakeholders • Developing technology for reducing the amount of platinum used. • Developing technology for reducing of amount of carbon fiber in hydrogen storage systems
HRS	● 320 by FY2025, some 900 by FY2030 ● Making HRS independent by the second half of the 2020s ● Reduction of cost for construction and operation by FY2025 (construction cost ¥350m→¥200m, operation cost ¥34m/year→¥15m/year) ● Setting of cost target for each component （Compressor ¥90m→¥50m High pressure vessels ¥50m→¥10m）	• Thoroughly integrate promotion of regulatory reform and technological development （Realization of self-service HRS, use of inexpensive steel material etc.） • Consideration for nation wide networking of HRS • Extending opening hours • Increasing of the number of HRS with gasoline station/convenience store
Bus	● 1,200 FC buses by 2030 ● Expansion of regions where FC buses run ● Reducing FC bus's price by half (¥105m→¥52.5m) ● Independent FC bus by FY2030	• Developing technology for enhancing the fuel efficiency and durability of such vehicles • Expansion of types other than city buses • Promotion of deployment of HRS for FC buses
Forklift	● 10k FC forklifts by 2030 ● Expansion to an overseas markets	• Versatile deployment of fuel cell units • Promotion of maintenance of simple and easy to operate filling equipment

※In addition, promote development of guidelines and technology development for expansion of hydrogen use in the field of FC trucks, ships and train.

Key points of the Action plan ② (hydrogen supply chain)

Red: New Target

Acceleration of RD&D to establish technologies for future hydrogen mass-consuming society

Goals of hydrogen supply chain

- H2 CIF cost : ¥30/Nm3 in 2030, ¥20/Nm3 in the future
- The future reduction of the H2 cost to the same level as conventional energy sources (e.g. LNG) will be necessary .

Hydrogen cost that matches the LNG cost 10$/MMBtu is ¥13.3/Nm3 (calorie equivalent)
※without consideration of the environmental value.

- Expansion of hydrogen supply network by building government-level relationships with resource-rich countries
- The development of the basic technologies to reduce hydrogen cost, targeting all processes, from hydrogen production to hydrogen transport

	Targets	Action to achieving the targets
Hydrogen supply chain / Fossil fuel +CCS	● Toward realization of hydrogen supply cost of 30/Nm3 around 2030, Targets by the first half of 2020 are set assuming the success of Japan–Australia Brown Coal-to-Hydrogen project. <Hydrogen production> ✓ Cost reduction of hydrogen production through brown coal gasification (¥several hundred/Nm3 during brown coal-hydrogen project →¥ 12/Nm3) <Hydrogen storage and transportation> ✓ Improvement of the efficiency of liquification (13.6kWh/kg during brown coal-hydrogen project → 6kWh/kg) ✓ Scaling-up of liquefied hydrogen tank (several thousand ㎥ during brown coal-hydrogen project → 50,000㎥) <CCS> ✓ Cost reduction of CO2 separation (about ¥4,200/t-CO2 in Japan → ¥2,000 level/t-CO2)	• Technological development for scaling-up and higher efficiency of brown coal gasifier • Development of an innovative liquefier structure (non-contact bearing) enables highly efficient hydrogen liquefaction • Development of technologies capable of manufacturing LNG-like large tanks with high insulation properties • Development of low-cost CO2 capture technologies (e.g. physical absorption)
Green Hydrogen	● Establishment of the technology of hydrogen production from Renewable energy System cost of electrolyzer:¥200,000/kW → ¥50,000/kW by 2030 Energy comsumption:5kWh/Nm3 → 4.3kWh/Nm3 by 2030	• Expansion of the demonstration in model regions for social deployment utilizing the achievement in the demonstration in Namie, Fukushima • Development of electrolyzer with higher efficiency and durability • Development of supply chain utilizing local resources

Key points of the Action plan ③ <other applications for a global "Hydrogen Society" >

Red: New Target

Developing and deepening the market to expand the application of hydrogen
International cooperation led by Japan for realizing a Global "Hydrogen Society"

		Targets	Action to achieving the targets
Hydrogen utilization	Power	● Establishment of the technology for commercialization of hydrogen power generation in about 2030 ✓ Clarify conditions for hydrogen co-firing at existing power plants ✓ Achieve higher efficiency of hydrogen mono-combustion by 2020 (26%→27%) ※1MW class gas turbine	• FS on limit mixture co-firing rate, feasibility etc. • Development of highly efficient combustor
	Industry	● Utilizing CO2-free hydrogen in the future ● Considering the introduction of the various processes for using CO2-free Hydrogen in a sequential manner as the processes achieve economic rationality	• Investigation on utilization and supply potential of CO2-free hydrogen in each industrial process • Study for practical application of carbon recycling technology
	Stationary fuel cell	Ene-farm ● Economic independence in about 2020, 5.3 million cumulative sales by 2030 ● Cost reduction to ¥800 thousand (PEFC) ¥1 million (SOFC) by 2020 ● Achieve 5 years as a period to recover investment by about 2030 Commercial and industrial use ● Realize grid-parity combining the utilization of exhaust heat in about 2025 (Low voltage : CAPEX ¥500,000/kW, power generation cost ¥25/kWh high voltage : CAPEX ¥300,000/kW, power generation cost ¥17/kWh) ● Realize higher efficiency and durability (efficiency : over 55% in about 2025 → over 65% in the future durability : 90,000 hours → 130,000 hours in about 2025)	• Development of markets such as existing housing and condominium. • Review of regulations for simplification of electrical work • Development of fuel cell stack technologies for higher efficiency and higher power density • Development of fuel cell stack technologies to eliminate the cause of degradation
Global Hydrogen society/ social acceptance		● Realize "Tokyo Statement" announced in Hydrogen Energy Ministerial Meeting ✓ Coordination on harmonization of regulation, codes and standards ✓ Promotion of information sharing, international joint research ✓ Study and evaluation of hydrogen's potential ✓ Communication, education and outreach	• Comparison of regulations with U.S., Europe, etc., sharing information on accidents • Involvement of resource-rich countries by sharing the outcome of Japan's supply chain demonstration • Take advantage of all opportunities such as Olympic and Paralympic in 2020, Osaka World Expo in 2025, and publicize the cutting-edge hydrogen technology • Implement innovative technology development